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Vitality through

Vitality Through Planned Nutrition

REVISED EDITION

Poise, charm, and attractiveness go hand in hand with health.

Vitality Through Planned Nutrition

REVISED EDITION

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by

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Consulting Nutritionist

Author of

"Optimum Health," "You Can Stay Well," and
"Let's Cook It Right"

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Dedicated to
the high-school student
who appreciates both the
immediate and the fu-
ture values of full health.

PREFACE

The purpose of this book is to portray the relationship of nutrition to health and vitality, which are foundations of human happiness. Although many factors contribute to the building of vitality, the most fundamental consideration must be that of the choice of foods.

It was the dream of the late Dr. Mary Swartz Rose that nutrition be taught to every student in every school in our country. It is with her dream in mind that the author has prepared this book. It is written not merely for the relatively small groups of girls who specialize in dietetics, but for all boys and girls who will derive lifelong values from the study of the subject. The author, therefore, has tried to tell the story of nutrition in language understandable to high-school students and in a manner which will make them want to apply their knowledge immediately and throughout all the years to come.

The author wishes to express her thanks to the many friends, physicians, and professors who have aided her in the preparation of this manuscript, especially to Mrs. Iris Albert and to Miss Winifred MacDonough, both of the Home Economics Department of the Los Angeles City Schools, and to Dr. Walter R. Campbell and the Canadian Medical Association for permission to quote from Dr. Campbell's book *Nutrition in Everyday Practice*.

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PART ONE

WHAT NUTRITION CAN DO FOR YOU

Chapter 1

WHAT NUTRITION CAN DO FOR YOU

This book is going to tell you how to build health and vitality through nutrition.

Perhaps up to this time you have taken your health for granted. If you have felt well, that was fine; if you were ill, that was hard luck. In either case you may have seen no connection between how you felt and what you ate. Actually, what you eat determines to a very large extent how you feel. Furthermore, it determines how you look: whether or not your eyes are bright, your skin smooth and ruddy in color, your hair glossy, your teeth even and free from decay. It determines whether or not you stand erect, your head held proudly, for what you eat determines the strength of your muscles. It determines how you act, whether or not your lips are quick to curve into a smile, whether or not your disposition is pleasant, whether or not your energies are abundant. What you eat can even determine how clearly and how quickly you think.

Your leaders, your outstanding students, and those whom you most admire show attributes of health which can come only with adequate nutrition: vitality, efficiency, endurance, cool-headedness, vivacity, mental alertness; yes, even grace, charm, and beauty. The application of a knowledge of nutrition can help you to have these qualities if you do not already possess them.

Nutrition is a personal subject. This book on nutrition is about you and your health problems; how you can solve those problems and also prevent others throughout the years to come.

Need for planning nutrition. A few generations ago, people did strenuous physical work and therefore had to eat large amounts of food. The more food they ate, the greater the quantity of health-promoting substances they received. At that time, there were no refined foods, therefore all foods contained valuable vitamins and minerals. By eating large amounts of food, all of which was rich in body needs, a good diet was automatically obtained and there was little need of nutritional education.

The people today who take vigorous exercise can consequently eat large amounts of food, and if they happen to prefer natural foods to refined ones, they, like our ancestors, automatically obtain a relatively good diet. Such people, however, are not many.

The average person today takes such a limited amount of exercise that he can eat only a little food unless he is to become overweight. Our foods are now so often refined that about 66 per cent of all calories eaten come from foods which have had most of the vitamins and minerals removed. Transportation, storage, canning, and drying cause a further loss of food value which did not occur when each family had its own garden. These changes combine to make it almost impossible for us to obtain a health-building diet automatically. If left to chance, the choice of foods, therefore, can rarely produce health.

The majority of people do leave their choice of foods to chance and, as a result, they are below par both physically and mentally. They lack vitality, resistance to disease, and efficiency. But you, the alert high-school student of today, want health. You know that it is of great value to you. It follows then that your nutrition must be planned.

Body requirements for full health. The science of nutrition is essentially the study of what happens to foods after they are eaten: how they are absorbed into the blood and carried to the

billions of cells throughout the body to be used for building and repair or to produce energy and heat; how these foods help each organ of the body to carry on its work normally; how worn-out tissues are torn down and waste products are removed from the body. When perfection is reached in building and repair, when each organ of the body functions normally, and when all wastes are completely removed, then is full health sustained.

In order to have full health, you must provide the body with *proteins, fats,* and *carbohydrates* (starches and sugars). Fats and carbohydrates are used chiefly to supply energy and heat. The principal function of proteins, which are obtained from such foods as milk, meat, eggs, and cheese, is that of building body tissue and keeping it in constant repair. Besides these three food classes, *minerals* are needed to build bony structures and to regulate the functions of all body cells. *Vitamins,* which like minerals cannot be used for energy, are substances necessary to help the body carry on its work. *Water* is as important as any of these.

The body requirements needed for full health are made up of the three classes of foods, fats, carbohydrates, and proteins; water; all the minerals, and all the vitamins. Each of these requirements will be given detailed attention in later chapters.

Equal importance of body requirements. It cannot be overemphasized that each of the body requirements is as important as the others. For example, it is as essential for the diet to contain adequate amounts of minerals, such as phosphorus, as of any one of the vitamins. Phosphorus is rarely lacking in the American diet. However, several of the vitamins frequently are.

In this book, each body requirement is discussed in proportion to the frequency of its lack in our national diet. Nevertheless it is of utmost importance to obtain a grasp of the subject

as a whole and to realize that each requirement has an essential part to play. Vitamins have been in the limelight too many times, and, as a consequence, equally essential requirements have been overlooked. Nutritional knowledge can be of value only when seen as a whole.

A standard of judgment. A knowledge of nutrition gives you a standard of judgment in evaluating the many conflicting opinions concerning health practices. Someone has said that the trouble with the nutritional knowledge of the general public today is that most of it is not true. Certainly false opinions are all too common. No statement concerning health has value unless it has been proved to be correct by scientific research. You must be able to recognize falsehoods which masquerade as truths.

The truth, on the other hand, is frequently distorted so as to appear false. This practice is often due to the skepticism of intelligent persons. Such skepticism protects them against misinformation but may also cause them to devaluate scientific knowledge. For example, a football player learned that the B vitamins were needed in larger amounts by an athlete than by the bookworm. He mentioned this need to his coach, who happened to be uninformed in nutrition and was told that vitamins were the "bunk." What was the boy to believe? Parents and persons well-informed in other respects and even physicians sometimes hold that coach's point of view. Such attitudes are all the more disturbing when held by people whom you admire and whose intelligence you respect. You can readily separate the truth from the falsehood, only if you are fortified with scientific facts.

Food racketeers. A great deal of misinformation has been spread by certain quacks or food faddists who are best characterized by the term *food racketeers*. In order to fatten their own pocketbooks, such persons unscrupulously prey upon a

Sports demand stamina, speed, and perfect co-ordination of muscle.

too often gullible public. They sprinkle their vocabulary freely with scientific terms which are not understood by the untrained person. They care little about improving health, and the information they give is such a harmful mixture of truth and falsehood that it is more difficult to discern than glaring lies would be. Only sound health education can replace notions with facts and so help you to judge which statements are true and which are false.

Fraudulent advertising. Much misinformation has been broadcast through fraudulent advertising. On the other hand, reliable advertising gives accurate information and renders a definite service to the public. The problem resolves itself into the buyer's ability to tell the true from the false.

Most of the large food and drug companies have research laboratories where chemists constantly analyze and investigate

the products put out by their firms. These men have contributed much to scientific information. The pure food and drug laws are so extremely exacting and so well enforced that a misstatement on the part of large companies would bring law suits costing many thousands of dollars. That is why accuracy is so carefully sought even if some firm, of its own accord, might not wish to be honest. For these reasons, advertising on the part of any well-known company may be, in general, relied upon as truth. Their advertising is carefully examined by the Pure Food and Drug Administration of the United States Government and the Committee on Foods and Nutrition of the American Medical Association which have done much to prevent the use of incorrect statements, misleading terms, and exaggerated claims.

Nevertheless, some small companies, managed by unethical people, occasionally plan to make money until such time as the government authorities catch up with them. Since the number of these small companies runs into the thousands and the products which they put on the market into many thousands more, the government cannot investigate all of them as quickly as each appears. As a result, unscrupulous producers grab their money quickly, for they know they will eventually be closed down by pure-food and drug-enforcement agencies. In the meantime, however, they have flooded the market with untruthful advertising and spread misinformation which takes years to correct. True nutritional information comes only from scientific research.

Animal experiments. Since nutrition is essentially concerned with the breakdown and utilization of foods in the body, facts concerning these foods must be learned from the study of such changes in *living* bodies. For this reason, animals have been used in experimental investigations.

Rats, generally considered a menace to mankind, have been

used in making great contributions to scientific information. These animals are most often used in nutritional experiments because they cost little to feed, they readily eat the same foods we eat or adjust themselves to purified diets, and several may be stored in a small space.

Although it may be pointed out that the rat is in many ways different from the human being, actually its body processes are very much the same. Like the human being, it has muscles, bones, blood, a nervous system, glands, and a digestive tract. Its heart is controlled by the same kind of mechanism as man's, and it reacts in about the same way to excitement, fear, and pain. The production of energy and the maintenance of body heat are controlled in the same way. Taken detail by detail, from the contractions of the intestinal tract to the vibration in the ear which makes hearing possible, the fundamental processes of life are the same in both humans and rats. On the whole, the rat's value lies in the fact that it is, nutritionally speaking, very similar to man.

Other animals are also used in experimental work: birds, guinea pigs, rabbits, dogs, sheep, monkeys, horses, and cows. Most of these are more expensive to feed and to care for than rats. Each species is particularly well adapted to certain types of experiments. For example, when studies are to be made on the length of life, the rat, which lives a little more than two years, is especially valuable, whereas a very few generations of horses or cows could be observed.

There are hundreds of laboratories throughout the world where scientific research is being carried on. These laboratories are found in almost every university, in every large commercial food company, and in many companies which make pharmaceutical products (drugs). A tremendous amount of knowledge has already been gained.

On the other hand, the science of nutrition is as young as

aviation, and there is still much to be learned. The essentials of nutrition will probably be little changed by future research, but a great deal of new knowledge will be added.

You must be on your guard to be always open minded. to keep abreast of new knowledge as it becomes known, and to realize that the information given in this book is by no means complete or final.

Interpretation of material. Since a relatively larger amount of any body requirement is needed during growth, scientists most often give deficient diets to young animals because the effect shows itself quickly. The most obvious result, however, when young animals are used, is a stunting of growth.

It is easy for the high-school student to jump to the conclusion that such a requirement is needed only during growth. He may feel that he is either grown or almost so, and therefore decide that the experiment has no application to his immediate life. What the student may fail to realize is that any requirement needed during growth is also necessary to maintain health throughout life. The greater the stunting of growth, the more harmful is a diet which is deficient in the factor in question, at any time during life. Graphs and pictures showing growth differences, therefore, should be interpreted to prove that the requirement in question has a profound effect upon your own immediate life.

Vitality through planned nutrition. By far the greatest value nutrition has to offer you is that of helping you to build your own health now and in the years to come. The scientist who works with laboratory animals knows that, if he gives his animals foods which supply all of their body requirements, health is produced. If, on the other hand, he omits from the animals' diet only one body requirement, such as only one vitamin, or one mineral, or if he supplies too few calories, he knows that

his animals will not be healthy and that disease will be produced. Yet, even when the diet contains every body requirement, if one or more factors are but slightly deficient, again ill health and perhaps disease will result.

It is now becoming evident that the same facts apply to human beings. If every body requirement is generously supplied in your diet, day after day, positive, glowing health is produced. The diet, however, must also be supported by ample sleep, rest, fresh air, exercise, and freedom from worry. Even though these factors are supplied, if one requirement is lacking from the diet or is supplied in an inadequate amount, either the seed bed of disease is planted or disease is produced. Neither sickness nor health is any longer a matter of chance. Actually, the average diet is likely to be undersupplied in many body requirements rather than completely lacking in any one. The degree to which the diet is adequate or inadequate will cause many degrees of either health or disease, ranging on a sliding scale from radiant, vibrant health to severe disease. Your location on that scale will depend largely upon the adequacy or inadequacy of your diet. The choice is up to you. Surely that choice will be full health,—the highest degree of health which you can attain. If this is your desire, your nutrition must be planned, otherwise you have little chance of reaching your goal.

Vitality through planned nutrition means: *first,* that you must know what the body requirements are; that is, what substances are needed to develop and maintain a perfectly nourished body; *second,* you must know how much of each requirement is needed by you, as an individual, to promote your own health; *third,* you must actually plan a nutrition program and eat foods day after day which contain every requirement in amounts ample for you as an individual. When your nutrition

is thus planned, vitality will result. Your vitality and your health are assets which are too important to you to be left to chance.

Projects

1. Bring some advertising material to class. As the study of nutrition progresses, criticize the statements made and classify the material as ethical or unethical advertising.
2. Obtain books or articles written by food faddists. At the end of the semester, read and criticize them. Point out why certain statements are untrue.
3. If a nutrition laboratory is accessible, visit it and learn all that you can about the method of conducting animal experiments.
4. Select some person whom you consider to be in ideal health. Study him carefully and write out all the differences you can observe between him and another person whose health you consider to be mediocre.
5. Select five persons whom you believe to be healthy. Now classify them in order as the most healthy, the second most healthy, and so on. Write all your reasons why you would classify them in this way. Do you see that there are degrees of health?

   Keep the above papers in your notebook to be compared with others written later. As the course advances, other differences between full health and passable health will become obvious.

Chapter 2

HOW FOODS ARE DIGESTED

The process of digestion, through a series of changes, breaks down foods so that they dissolve in water and pass readily through the intestinal wall into the blood.

Early studies in digestion. Long ago it was thought that, during digestion, foods were mashed mechanically into particles small enough to pass into the blood. This idea was incorrect. The first knowledge of digestion was contributed during the eighteenth century by a Frenchman, named Réaumur. He had a pet hawk to which he fed sponges. Since hawks spew up undigestible materials they have swallowed, this scientist knew the sponges would soon be returned saturated with the digestive juice from the stomach, known as *gastric juice*. He wrung out the sponges, collected the juice, and dropped various types of foods into it to see what happened. He found that some foods were broken down and others were not.

A few years later, an Italian, Spallanzani, used a sort of fishing-tackle method to study digestion in birds, cats, dogs, sheep, cows, horses, and even himself. Foods were tied to the end of strings, then swallowed, and later pulled up. Spallanzani also put bits of food into perforated metal capsules, swallowed them, and later recovered them from the feces (solid body wastes). Since the food disappeared, even though the capsules were not crushed, the process of digestion was proved to be chemical rather than mechanical.

Thorough studies of stomach digestion were made years

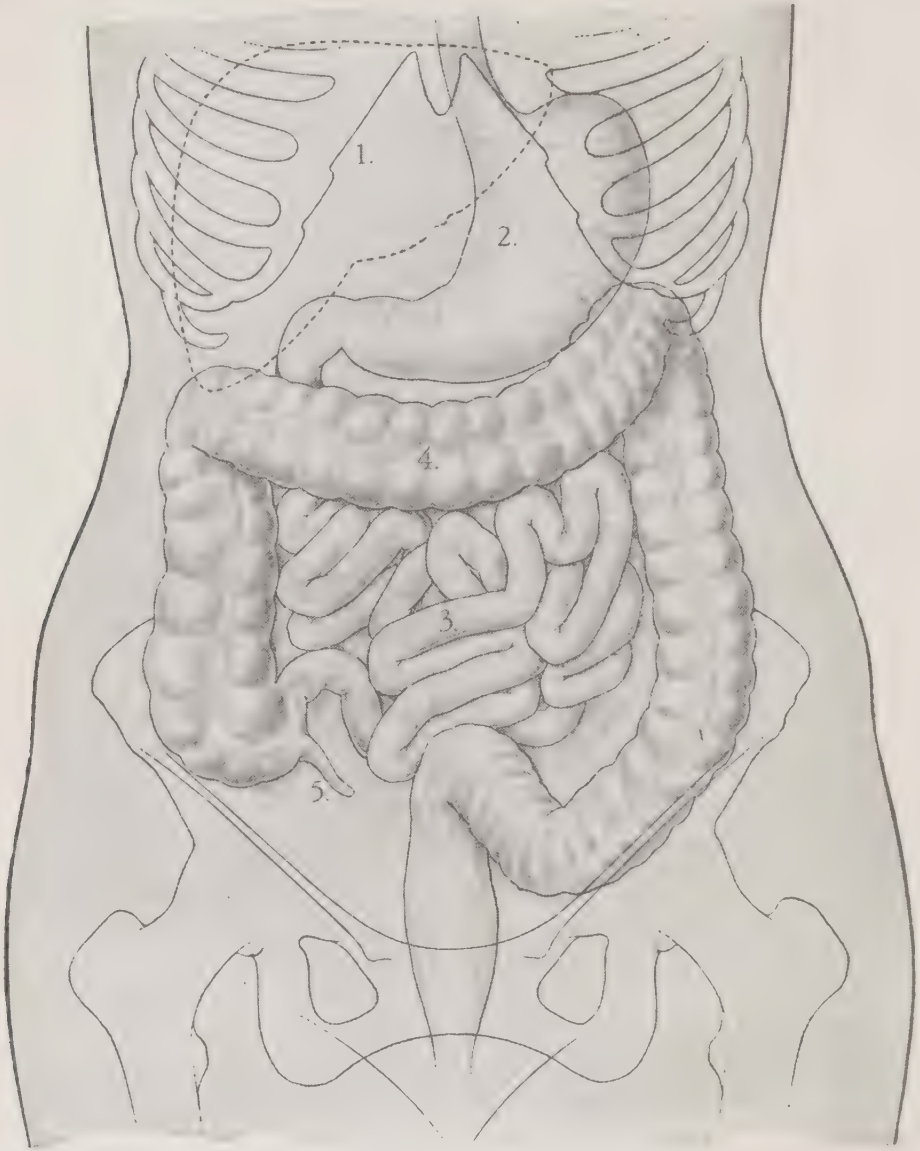


Diagram of the digestive tract: (1) Liver, shown by dotted line; (2) Stomach; (3) Small intestine, about 24 feet in length in normal adult; (4) Large intestine, about 4 feet in length; (5) Appendix.

later by Dr. Beaumont, who lived on an isolated island in the St. Lawrence River. He discovered a French-Canadian soldier, Alexis St. Martin, who had a bullet wound in his stomach which

had healed in such a way that there was an opening directly to the outside. This gave Dr. Beaumont an opportunity to study the factors which increase the flow of digestive juices and also the extent of stomach digestion. Foods were tied on strings, dangled in the stomach, withdrawn, and observed. Dr. Beaumont found that when he tickled the stomach of his subject with a feather, more digestive juices were secreted. On the other hand, he found that anger, fear, fever, and alcohol—for Alexis St. Martin was much given to drink—all decreased the flow of the gastric juices. Since St. Martin did not enjoy being experimented upon, he often became drunk and went off into the Canadian woods. Sometimes it would take several months for Dr. Beaumont to locate him again. Nevertheless, Dr. Beaumont from his observations of this case contributed much information hitherto unknown.

In the years that followed, the acid in the stomach was proved to be *hydrochloric*. A substance which helps to break down or digest protein foods found largely in milk, eggs, cheese, and meat was also discovered and given the name of *pepsin*.

The next great contribution to the better understanding of digestion was recently made by Pavlov, the eminent Russian physiologist, who experimented with dogs. He found that when the dogs were apparently happy much greater quantities of digestive juice were produced than when the animals were angry. He showed that the flow of stomach juice was stimulated by merely the thought of food. If a dinner bell were customarily rung at the time food was given, gastric juice would begin to flow as soon as the bell was rung, even when there was no food. He found that the larger the amount of food given, the greater the flow of gastric juices, and that certain foods caused greater production of digestive juices than others.

The work of enzymes. During digestion, food is broken down from large pieces (such as those which might be swal-

lowed by a boy more eager to play ball than to eat lunch) into molecules or particles which are so extremely small that they dissolve in liquid and pass readily into the blood. This breakdown is brought about by the action of substances known as enzymes.

Enzymes are tiny bits of protein which are produced by living cells. They have the power to combine chemically with other substances. In the case of the digestive enzymes, the particle of food, after it has combined with the enzyme, breaks off from the mother substance. This process continues until the digestive enzymes have broken the food particles into molecules which can dissolve in liquid and pass readily through the intestinal wall into the bloodstream. Without enzymes, digestion could not take place.

Hunger and salivary digestion. The stomach is nothing more than a bulge, or an enlargement, at the top of the intestinal tract, surrounded by circular muscles. These muscles contract, causing the stomach walls to squeeze together, to a certain extent all the time. The movements of an empty stomach, however, are much more rapid and vigorous than when it is full. Hunger occurs whenever the contractions of the stomach walls are sufficiently vigorous to cause pain.

Thought, sight, or smell of food stimulates the flow of saliva. Actual chewing of food causes a further pouring out of saliva. Fear or excitement inhibits its flow. Saliva contains an enzyme which can digest starch but which can act only in neutral or slightly alkaline liquid. The digestion of starch begins as soon as the food is well chewed, but food is held in the mouth too short a time for much actual breakdown to take place. The purpose of saliva is to moisten food and to facilitate swallowing rather than to aid digestion, whereas the purpose of chewing is to increase the surfaces exposed to digestive juices and enzymes throughout the alimentary tract.

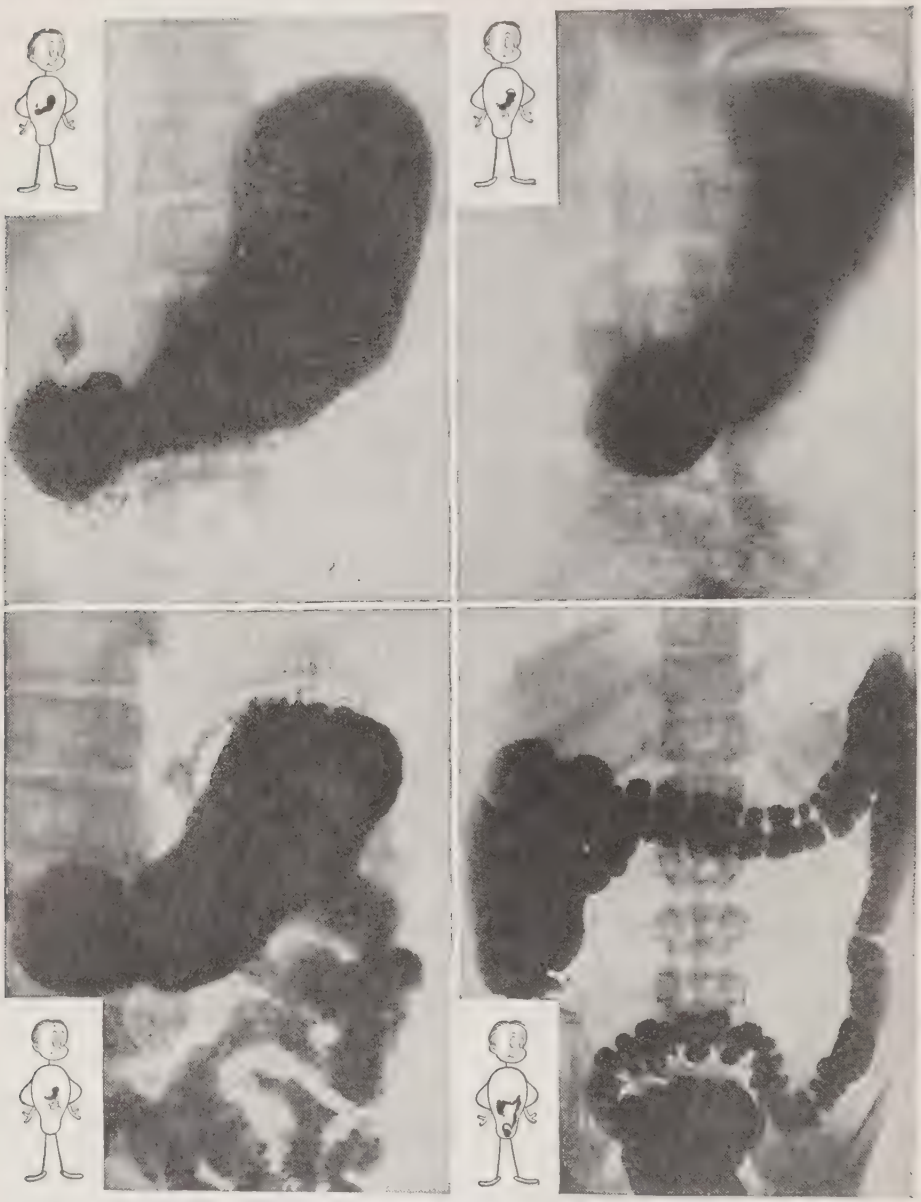
Mechanics of digestion in the stomach. The stomach expands or contracts, depending upon the amount of food it contains. It actually never has any empty space but is as large or as small as its contents. The empty stomach is a shriveled pouch containing only digestive juice.

The end of the stomach nearer the heart is very elastic, can stretch to many times its size, and is a storage place for food rather than an organ of digestion. Food remains here for from thirty minutes to two hours after a meal, depending on the amount eaten. Very little movement takes place in this part of the stomach, hence there is no general mixing of the entire stomach contents.

The end of the stomach nearer the opening into the small intestine is muscular. Vigorous movements and contractions of this muscular end churn foods and mix them with the digestive juices and enzymes.

Gastric juice. In the walls of the stomach there are many glands which produce gastric juice. The stimulation of the flow of gastric juice, like that of the saliva, is set up by the thought, taste, sight, or smell of food. The flow of gastric juice is also stimulated mechanically by the presence of food itself, and chemically by certain foods such as meat, meat juices, acid fruits, and toast. For this reason, melba toast and bouillon are often given to invalids, and fruit cocktails and soups are served at the beginning of meals.

The gastric juice contains some mucus, large amounts of water, hydrochloric acid, and the three enzymes, known as *pepsin, rennin,* and *lipase*. Pepsin breaks down protein foods, such as meat, fish, eggs, and cheese, into simpler protein substances which can be further acted upon by enzymes in the intestine. The enzyme lipase breaks down fats, but stomach lipase, which cannot act in acid, can digest very little fat. The enzyme rennin causes the protein in milk to form curds.



X-ray photographs showing the digestion of a glass of malted milk. When a substance known as barium, which shows in X-ray photographs, is mixed with food, pictures can be made of the progress of digestion.

1. In this picture (upper left), the stomach contains only a glass of malted milk in which barium has been mixed. The stomach is larger than if it were empty, but smaller than if a hearty meal had been eaten. The shadow slightly above the lower end of the stomach and the scattering of dot-like shadows below the stomach show that only a little food has passed into the small intestine. The upper portion of the stomach is momentarily relaxed.

2. This picture (upper right) was taken shortly after picture 1. Four waves of muscular contractions, which mix the food with digestive juice and enzymes, can be seen in the stomach walls. The difference in the shape and the position of the stomach in pictures 1 and 2 is due to these contractions. Slightly more food has passed into the small intestine (shown by the shadows at the lower center of the picture). The dark line at the upper end of the stomach is the diaphragm, against which lies the upper stomach wall.

3. This picture (lower left) was taken after picture 2. Notice that the stomach is much smaller than in previous pictures. Three contractions of the stomach walls can be seen. The small intestine, which is about 24 feet long in the normal adult, is shown crossed and criss-crossed on itself. The barium meal, dispersed throughout the 24 feet, gives a less clear picture than when it is concentrated in the stomach. The irregular lining of the small intestine shows the folds which increase the absorbing surface.

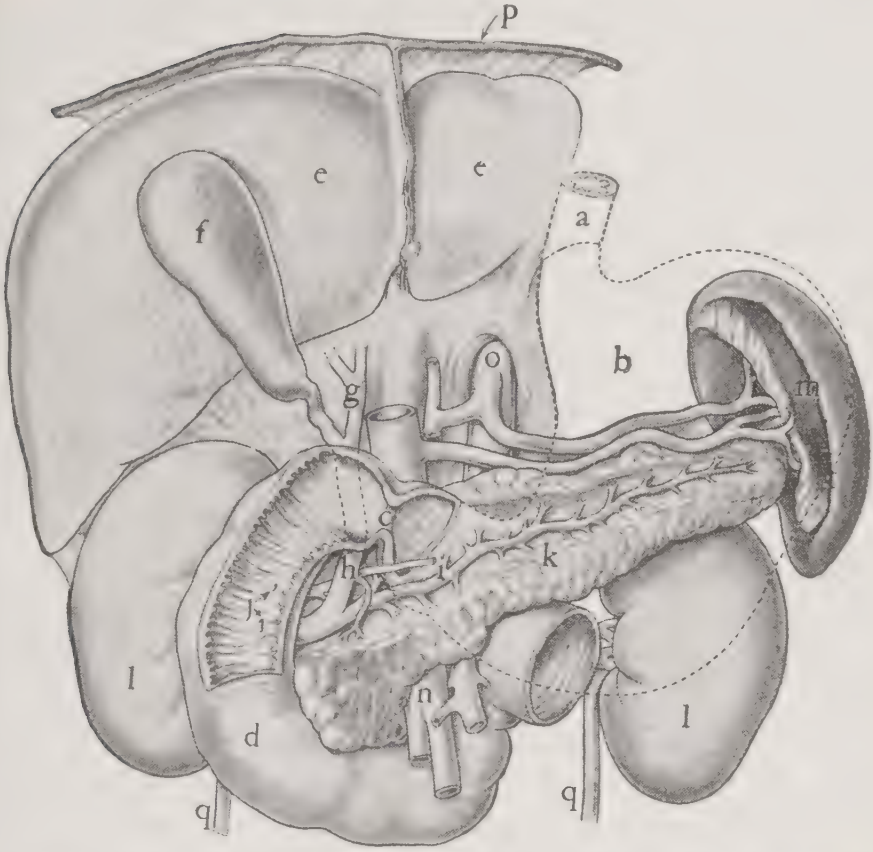
4. This picture (lower right) shows the large intestine distinctly outlined and filled with barium. No food remains in the small intestine. The large intestine is expanded in portions which holds the food mass, and appears small in sections which contains little or no food material. Notice the appendix at the left of the picture connected to the first section of the large intestine. The small intestine empties into the large intestine slightly above this point.

The solid curds are held in the stomach long enough for them to be acted upon and partly digested by pepsin, whereas if the milk were left in its original liquid form, it would leave the stomach before digestion could take place.

Foods leaving the stomach. Solid food in the stomach is mixed with whatever liquid is drunk and with two to three cups of enzyme-containing gastric juice, the amount depending upon the quantity of food eaten. As digestion takes place, these solid foods are changed to a semiliquid consistency. Foods leave the stomach as soon as they are reduced to this semifluid state. Foods may not necessarily reach the stage of greatest stomach digestion possible, therefore, before they pass into the small intestine. For example, a raw egg is so nearly liquid that it leaves the stomach quickly and almost completely undigested. Similarly, much value is lost from a soft-cooked egg. A hard-boiled egg stays in the stomach longer, and hence digests much more completely. In the same manner, unground meat or pieces of cheese are more completely digested than ground meat or grated cheese because they stay in the stomach longer. The dog uses good instinct in bolting his food. He fails to obtain the full value of meat if it is fed to him ground.

The length of time food remains in the stomach depends also on the amount and kind of food eaten. The stomach may be empty at the end of two hours after a small meal, in five hours after a moderately large meal but may retain a Thanksgiving dinner for six or seven hours. Fats, if taken alone, stay in the stomach longer than other foods. Carbohydrates, (starches and sugars) leave the stomach most quickly.

A circular muscle forms the "door" between the stomach and small intestine. This muscle relaxes at the end of each major contraction of the stomach walls. An opening is thus formed, and a small amount of food is allowed to pass into the small intestine.



Organs of upper abdomen concealed by stomach and intestines: (a) Esophagus; (b) Stomach shown by dotted lines; (c) Valve between stomach and small intestines; (d) Section of small intestine known as the duodenum; (e) Liver, raised in order to expose organs; (f) The gall bladder, a reservoir for bile; (g) Canal which carries bile directly from liver to small intestine; (h) Canal which carries bile from both the gall bladder and liver to the small intestine; (i) Canal which carries pancreatic juice to small intestine; (j) Opening of canals from liver and pancreas; (k) Pancreas, showing cross section; (l–l) Kidneys; (m) Spleen, the graveyard of red blood corpuscles; (n) Vein which carries blood from the intestines to the liver; (o) Artery which carries blood from the heart to the digestive organs; (p) Diaphragm; (q) Canal from kidney to urinary bladder.

Digestive juices in the small intestines. As food passes gradually into the small intestine, digestive juices whose flow is sluggish in the absence of food, pour rapidly from the pancreas, the liver, and from the walls of the small intestine itself. The juice from the liver, called *bile,* is produced continuously, but, if no food is being digested, the bile is stored in a small sack, or reservoir, which is situated between the lobes of the liver and is known as the *gall bladder.* When foods enter the small intestine, the liver speeds up its production of bile and the gall bladder contracts so that it empties itself into a small canal known as the *bile duct* which also carries bile directly from the liver to the intestine. A similar canal, the *pancreatic duct,* carries digestive juices from the pancreas to the small intestine.

The most important digestive juice is that coming from the pancreas. In the normal person, as much as two quarts of pancreatic juice enters the small intestine daily, largely after meals. It contains water, alkaline-forming minerals which can neutralize the hydrochloric acid from the stomach, one fat-splitting, four carbohydrate-splitting, and eight protein-splitting enzymes.

Two types of specialized cells in the intestinal walls secrete juices. One juice contains much mucus and few enzymes and is largely a lubricant which protects the intestinal walls from being scratched or damaged. The other juice contains many enzymes which digest proteins, fats, starches, and sugars.

Though bile contains no enzymes, it is extremely important in the digestion of such foods as cream, butter, oils, and other fats. Bile causes fats to break up into tiny droplets. These tiny droplets may be completely surrounded by the fat-splitting enzymes and quickly digested. In the absence of bile, so few enzymes can combine with the relatively large pieces of fat that little digestion can take place.

Other foods in the intestinal tract are covered with melted but undigested fat which makes it impossible for protein— and carbohydrate-splitting enzymes to reach them. The lack of bile, therefore, indirectly interferes with the digestion of proteins and carbohydrates. Undigested foods in the intestinal tract support the growth of millions of bacteria. As a result, the person whose bile flow is diminished suffers much from gas and indigestion.

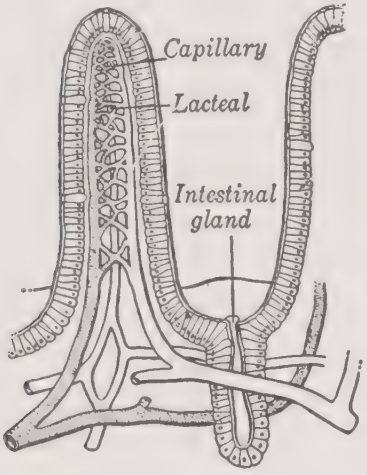
Mechanics of digestion in the intestinal tract. A series of running movements, made by contractions followed by relaxations of the muscles in the intestinal walls, mix the food with the digestive juices. These continuous movements make it possible for the enzymes to reach the surfaces of undigested foods and for the digested foods to come in contact with the intestinal wall. As digestion takes place, these muscular movements push unabsorbable material toward the large intestine.

Digestion takes place largely during the first three hours after food enters the small intestine, although the food-mass may remain there twelve hours or longer. By the time it is ready to pass into the large intestine, the greater amount of digestible material has been absorbed into the blood.

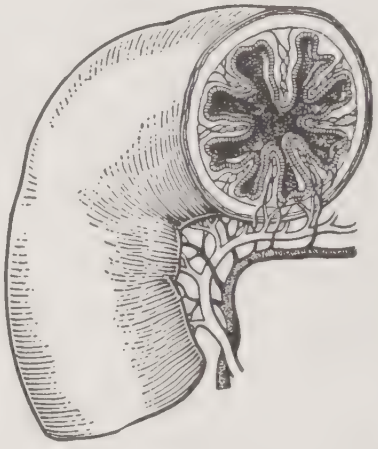
Absorption of foods. Absorption means the passing of foods from the intestines into the blood. The amount of wall space or surface of the intestines through which foods must pass greatly influences the speed at which food can reach the blood. The actual surface of the small intestine is about four square feet. However, because of folds and tiny finger-like projections, called *villi,* the surface through which food may be absorbed is increased to more than a hundred square feet.

Each tiny projection is supplied with capillaries (tiny blood vessels) and a small canal known as a *lacteal,* which is connected with the lymph circulation. Digested foods pass from the intestines into the blood capillaries or the lacteals.

In a healthy person, there are almost continuous contractions of the intestinal wall. The action of the muscular contraction is similar to that of squeezing water out of a sponge. As the wall contracts, the food-laden blood and lymph from the villi are squeezed into general circulation. The muscular relaxation which follows allows fresh blood and lymph to flow in, just as an unsqueezed sponge soaks up water. The return of the fluids which carry food is prevented by means of small doors, or valves.



Section of a villus.



A cross section of the small intestine. The villi are much magnified.

Blood from the intestinal wall empties into the large blood vessel called the *portal vein* and is carried to the liver. Here the blood deposits the larger amount of its food supply. The food carried by the lymph empties into the blood through a canal located in the chest and is later withdrawn by the liver.

In the same way, vitamins and minerals, which are freed during the process of digestion, pass from the intestine into the blood and lymph, and hence into general circulation.

Purpose of the large intestine. Very little, if any, absorption of food material takes place in the large intestine. The pur-

pose of this section of the digestive tract is principally one of water conservation. As the food-mass leaves the small intestine, it is semiliquid in form. Were it not for the large intestine, it would be necessary to drink great quantities of water to sustain life. Since sea animals have no need to conserve water, they have no large intestine.

Waste material remains in the large intestine about twenty-four hours, so that the absorption of water may take place. During this time the waste products gradually become more solid, and are pushed to the rectum or lower portion of the large intestine.

In cases of constipation, the muscles of the intestinal tract are so sluggish that the food mass remains in the large intestine longer than it should; too much water is absorbed and the feces become hard and dry. On the other hand, when cathartics are taken, much water is drawn into the intestinal tract, little or none is absorbed into the blood, and the cells throughout the body are often robbed of needed water. Cathartics also force foods through the intestine so quickly that complete digestion and absorption of foods cannot take place. Furthermore, cathartics irritate the delicate linings of the intestinal tract.

Projects

1. Buy rennin or junket tablets at a grocery store. Add one tablet to lukewarm milk. How can you explain the reactions? What process of digestion is similar to the change which occurs in the milk?
2. Chew a small piece of cracker, holding it in your mouth as long as you possibly can. Notice that the longer you hold it, the sweeter it becomes. What causes the taste to change?
3. Fresh pineapple contains a protein-digesting enzyme. If possible, purchase a fresh pineapple, chop the pulp well, and strain off the juice. Add to one portion of juice a small amount of ground round steak free from fat; to another portion, the white of one

egg; to another, a small amount of cheese. Keep lukewarm and observe what happens. Prepare fruit gelatin in the usual manner; divide into two portions. To one, add a small amount of raw pineapple. Why does the latter fail to set?

4. If a substance known as steak tenderizer may be purchased from your grocer, buy some and add generously to such protein foods as are mentioned in project 3. Observe carefully what happens.
5. Drug stores carry enzyme preparations which are used by people who do not digest food well. Obtain fat-, starch-, and sugar-splitting enzymes from your druggist. Mix the fat-splitting enzymes with butter, lard, or oil. Mix the sugar-splitting enzymes with a lump of sugar or piece of candy. Mix starch-splitting enzymes with cornstarch, and later taste the mixture to see if it is sweet. Observe the action in all cases. If meat tenderizer cannot be obtained, buy protein-splitting enzymes from the druggist and add to foods mentioned.

Topics for Discussion

1. How was it proved that digestion is a chemical process rather than a mechanical one?
2. What is the chief purpose of the stomach? What is gastric juice? Which of the following foods are digested in the stomach: milk; butter; potatoes; eggs; apricots; meat; spinach; cheese?
3. How is the flow of gastric juice affected by: cheerfulness? anger? pleasant thoughts of food? fear? severe illness? Can disagreements at the dinner table interfere with your digestion?
4. Mothers frequently consider babies to be ill when milk in vomited which is curdled and sour. Are the curds and sourness normal or abnormal? In what form is it best to eat eggs, meat, and cheese?
5. What causes hunger? the flow of saliva? the flow of gastric, pancreatic, and intestinal juices and of bile?
6. What harm would be done if no hydrochloric acid were secreted into the stomach? if no bile flowed into the small intestine? if there were few contractions of the small intestine? if no villi existed?
7. What is the purpose of the large intestine? Why does constipa-

tion occur? What harm may be done by taking laxatives and cathartics?

8. How was it shown that digestion was not mechanical? Copy the drawing on page 12 and identify each organ. Show how each one contributes to the digestion of foods.

Chapter 3

WHAT LARGE AMOUNTS OF SUGAR YOU EAT

Of the three classes of foods, proteins, fats, and carbohydrates (starches and sugars), fats, and carbohydrates are used largely by the body for the production of energy and heat.

When people first learn that the body needs sugar to supply energy, they frequently remark, "I eat very little sugar." On hearing of this requirement, mothers often become alarmed, thinking that they should give sugar to their babies or small children. They fail to realize that there are many kinds of sugar other than ordinary table sugar.

Sources of sugar. Every person gets quantities of sugar either directly or indirectly from the food he eats. Even the meat diet of the Eskimo, who may never have tasted sugar as we know it, contains about 15 per cent sugar.

Plants are nature's sugar manufacturers. Their green leaves utilize the radiant energy of the sun to make sugar and starches from water and the carbon dioxide of the air. Sugar and starches which may be used as energy-giving foods for people and animals, are held in the flower, stem, fruit, and roots or are stored in seeds of plants.

Single sugars. There are four natural sugars which occur as single particles, or molecules, and hence cannot be broken down easily. These sugars dissolve quickly in water. They pass unchanged from the intestinal tract into the blood. Their names—*glucose, fructose, galactose,* and *mannose*—need not be remembered. However, you must know that these sugars exist and may be used to supply you with energy.

All fruits, vegetables, and grain products contain either sugar or starch which changes into sugar during digestion. One tablespoonful of sugar can be obtained from the following amounts of food:

half a large banana
one tablespoonful of molasses
two-thirds slice of bread
two teaspoonfuls of honey
one small apple
two large dates

Glucose, sometimes called *grape sugar* or *blood sugar,* occurs in small quantities in the blood of all animals. This sugar is also widely distributed in nature and is found in almost all fruits and vegetables. Sweet potatoes, new Irish potatoes, sweet corn, and onions contain much glucose, and this form of sugar makes up more than half of the solid matter of grapes and honey. Fructose is found with glucose in most fruits, in many vegetables, and in honey. Galactose does not occur alone in nature but comes principally from the digestive breakdown of milk sugar. Galactose combined with other sugars and starches

occurs in plants. In brain and nerve tissues, it is combined with fats or proteins. Mannose is not so widely distributed as other sugars, but, combined with protein, it is found in both meats and vegetables. It is freed in digestion and passes slowly into the blood.

The double sugars. There are three double sugars which, during digestion, are broken into the particles of single sugars: *sucrose,* or ordinary table sugar; *maltose,* or malt sugar; and *lactose,* or milk sugar. Sucrose occurs mixed with fructose and glucose in almost all fruits and vegetables. For example, half of the solid matter in ripe pineapple and in the sweeter variety of carrots is sucrose. Maple and cane syrups, sorghum, and other molasses are largely sucrose. Commercial sugar, which is pure sucrose, comes from sugar cane and sugar beets. Sucrose is broken down in digestion into fructrose and glucose.

Maltose is formed from starch during the sprouting of plants. It is also formed in the digestive tract from the breakdown of starch and is further divided into glucose. Since many foods contain starch, which changes into maltose, this sugar is extremely important as a source of heat and energy to the body.

Lactose, or milk sugar, is found in the milk of mammals. Human milk is from 6 to 7 per cent lactose, and cow's milk usually contains 4 to 5 per cent. Lactose is less sweet than other sugars and dissolves in water less easily. In digestion, it is broken down into glucose and galactose.

Multiple sugars. There are a number of substances which are made up of hundreds of particles, or molecules, of glucose. Although these substances are not sweet to the taste, they are broken down during digestion into glucose and, in this form, pass into the blood. Starch is the most common multiple sugar and is our principal source of energy. It is found in all grains and foods made from grains such as bread, cereals, pastry, macaroni, and noodles; in dried beans and peas, rice,

potatoes, and many other roots and tubers. Three fourths of the solid material in most cereal grains and in mature potatoes is starch. Unripe bananas and apples contain much starch, but as the fruit ripens, the starch is changed into sugar. The process is reversed in young sweet corn and new peas, for the sugar changes into starch when the foods mature.

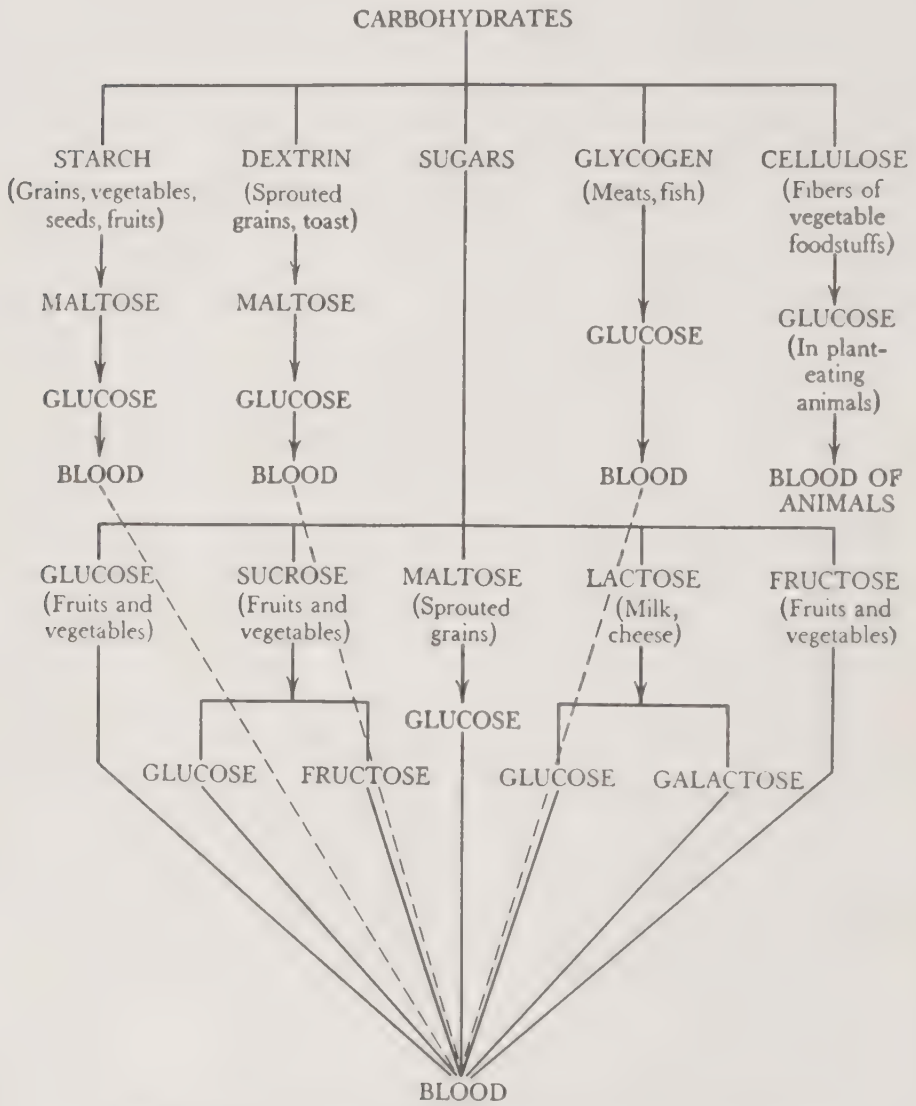
Dextrin is another multiple sugar. It is formed from starch when grains sprout, when breads or similar starchy foods are toasted, and when starch is cooked for a long time. In melba toast, the starch is almost entirely changed to dextrin. In the digestive tract dextrin is broken down first into maltose and then into glucose.

A third multiple sugar, *glycogen,* is a form of starch stored in our bodies and in animals' bodies to serve as a source of energy. When we eat meat, we get sugar from glycogen. The amount varies greatly and depends on the quantity of starchy food eaten by the animal before it was slaughtered. Liver is the principal storehouse for glycogen, or animal starch, and hence is the richest food source. Glycogen is changed into glucose in the digestive tract.

Cellulose, another multiple sugar, is broken down to glucose in the digestive tract of cows, goats, and other plant-eating animals. Human beings lack enzymes to digest cellulose, but it offers a valuable service by forming bulk which makes for intestinal hygiene. Examples of cellulose are the peelings and fibrous parts of fruits and vegetables, and the bran or coating of grains. These are often spoken of as *roughage,* a misleading term which causes people to visualize a sandpaper effect scraping the walls of their digestive tract. Actually cellulose is quite tender and smooth. Even bran flakes become soft when soaked in milk a few minutes.

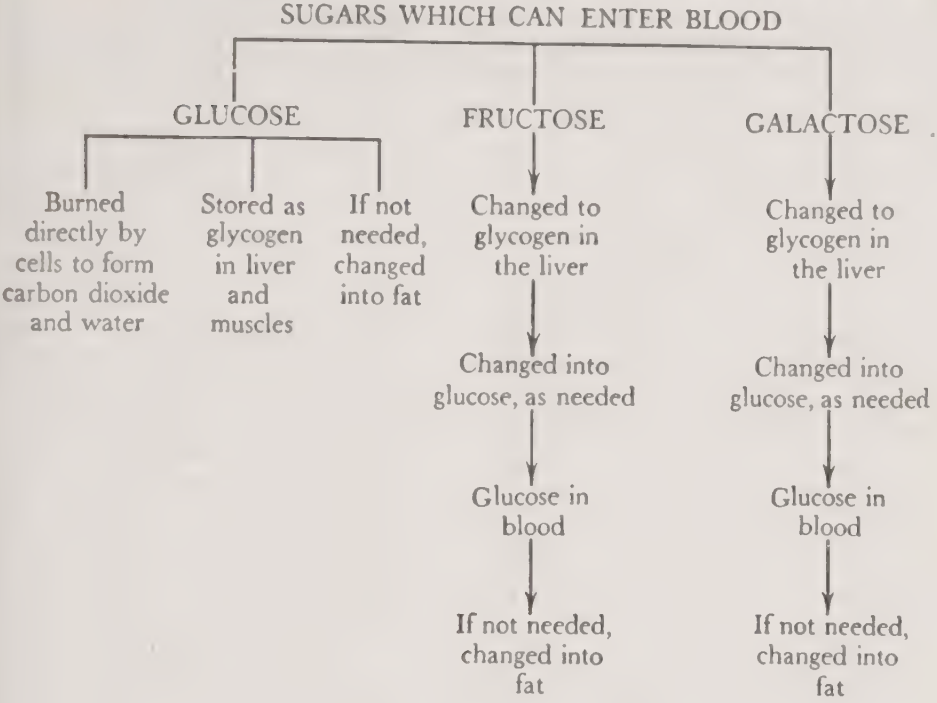
All sugars, starch, dextrin, glycogen, and cellulose are made of carbon, hydrogen, and oxygen. For this reason these are

spoken of collectively as carbohydrates. All are broken down during digestion to the three simple sugars, glucose, fructose, and galatose, which pass directly from the intestine into the blood.



All carbohydrates enter the blood as glucose, fructose, and galactose

The fate of carbohydrates in the body.


SUGARS WHICH CAN ENTER BLOOD
GLUCOSE
FRUCTOSE
GALACTOSE
Burned directly by cells to form carbon dioxide and water
Stored as glycogen in liver and muscles
If not needed, changed into fat
Changed to glycogen in the liver
Changed into glucose, as needed
Glucose in blood
If not needed, changed into fat
Changed to glycogen in the liver
Changed into glucose, as needed
Glucose in blood
If not needed, changed into fat

The fate of sugars in the body.

Other sources of sugar. About 10 per cent of digested fats is in the form of a substance called *glycerol* or glycerin. Glycerol may be burned in the body, as sugar is, to carbon dioxide and water, thereby producing energy, or it may be changed first into glycogen, or body starch, by the liver, and later into sugar. When proteins, which are broken down to amino acids during digestion, are used to supply energy, many of these acids are first changed into sugar. It is from these two sources, glycerol and protein, that the Eskimo gets his supply of natural sugar.

There are certain acids found in foods, which are not broken down by enzymes. They are carried in the blood by being combined with alkaline minerals, and may either be burned directly to produce energy or may form glycogen, or body

starch, which, in turn, is broken down into sugar. For this reason these acids should be listed as sources of carbohydrates. *Malic acid* occurs in apples, pears, peaches, tomatoes, and many other vegetables. *Citric acid* is even more widely distributed and is found in milk, meats, vegetables, and grains, as well as in citrus and other fruits. *Lactic acid* is obtained in appreciable amounts from buttermilk, sour milk, and cottage cheese. Other acids such as *oxalic acid* and *benzoic acid* occur in foods, but these are not easily used by the body and are excreted by the kidneys. Even though they are not carbohydrates, these substances which may be changed into glycogen in the body, all serve as sources of sugar and are spoken of as sugar-formers.

Fate of sugars in the body. Aside from the glucose which occurs liberally in most fruits and vegetables and passes directly into the blood during digestion, we have seen how glucose is formed from the breakdown of starch, dextrin, glycogen, table sugar, malt sugar, and milk sugar.

The body cannot change galactose and fructose directly into energy. These sugars are first carried by the blood to the liver, where they are converted to glycogen, which in turn may be changed to glucose as it is needed. On the other hand, glucose, which is called blood sugar, may be burned directly by the cells to produce energy. The glucose not needed immediately is changed into glycogen and stored by both the liver and muscles which are spoken of as the *glycogen depots*. The liver and muscles, however, can store only a limited amount of glycogen, and when they contain all they can hold, any excess glucose is changed into fat. Once changed to fat, it may never again be changed to glucose.

The sugar content of foods. With a few exceptions, fruits and vegetables are composed largely of water, cellulose or fiber, and either starch or sugar. Olives and avocadoes contain fat. Beans, peas, and corn supply appreciable amounts of protein.

The table which follows gives the carbohydrate content of fruits, vegetables, and some grain products in percentage of total weight. For example, 3 per cent of a pound of tomatoes is sugar. One pound of turnips would give you 1.6 ounces of sugar since they are 10 per cent carbohydrate. On the other

APPROXIMATE CARBOHYDRATE CONTENT OF FRUITS, AND VEGETABLES

	VEGETABLES	FRUITS
3%	Asparagus, Brussels sprouts, celery, chard, cucumbers, eggplant, kale, leeks, lettuce, pickles, rhubarb, spinach, squash (cream, Italian, summer)	
5%	Beets, cabbage, carrots, cauliflower, okra, onions (dried), peppers (green), pumpkin, radishes, string beans, watercress	
7%		Avocado, grapefruit, lemon, loganberries, olives, strawberries, watermelon
10%	Celery root, onions (green), oysterplant, parsnips, peas (canned), rutabagas, squash (Hubbard), turnips	Blackberries, cantaloupe, cranberries, muskmelon, oranges, peaches, pineapple (fresh), raspberries
15%	Lima beans (canned), peas (fresh green)	Apples, apricots, cherries, currants, grapes, huckleberries, nectarines, orangejuice, pears, pineapple (canned)
20%	Corn (green), lima beans (fresh), macaroni (cooked), navy beans (baked), potatoes (sweet, white, and yams), rice (boiled), spaghetti (cooked)	Bananas, figs (fresh), plums, prunes (fresh)
30%		Persimmons
75%		Dried fruits: apples, apricots, currants, figs, peaches, pears prunes, raisins

hand, if you ate a pound of dried fruit, you would be eating three fourths of a pound of sugar.

Ample supply of sugar without refined sugar. Practically every food we eat forms sugar either directly or indirectly, during or after it is digested. The person who is in the habit of choosing his food wisely receives all the sugar he needs even though he may never taste jams, jellies, candies, or refined sugar in any form.

Refined sugar satisfies the appetite more easily than any other known food. Aside from being used in the body to pro-

MEAL	GRAMS OF SUGAR FROM FOOD	APPROXIMATE TEASPOONFULS OF SUGAR
Breakfast		
orange juice, 7 ounces	18	3.6
prunes, 4 medium	29	6
oatmeal, ¾ cup	20	4
cream, ½ cup	2	0.4
egg, 1 medium	—	—
whole-wheat toast, 2 slices	30	6
milk, whole, 1 glass	10	2
Lunch		
sliced tomatoes	3	0.6
potato, baked	20	4
whole-wheat bread, 2 slices	30	6
apple, raw, 1 medium	15	3
graham crackers, 4	30	6
milk, whole, 1 glass	10	2
After school		
peanut-butter sandwich	35	7
banana, 1 medium	30	6
milk, whole, 1 glass	10	2
Dinner		
macaroni and cheese	30	6
peas, canned, ½ cup	10	2
carrots, ½ cup	5	1
lettuce salad	5	1
whole-wheat bread, 2 slices	30	6
whole milk, 1 glass	10	2
pear, 1 medium	15	3
dates, 6 large	37	7
Total for entire day	434 grams	86.6 tsp.

duce energy, which is easily produced from sugar from other sources, refined sugar has no value: it contains neither vitamins nor minerals.

The table on page 34 shows in grams the amount of sugar actually eaten in one day by a high-school boy who claimed that he never ate sugar. A gram is used as a unit of weight in scientific measurements. It is about one twenty eighth of an ounce. Since a teaspoonful of sugar is five grams, a serving of oatmeal such as that used in the table, supplies four teaspoonfuls of sugar after digestion.

Since one cup, or one-half pound, of sugar weighs 227 grams, this boy ate almost two cups of sugar in the course of one day. This large amount of sugar came from natural foods containing vitamins and minerals. Such sources of sugar are excellent builders of health.

Projects

1. Arrange a display of foods which contain all types of carbohydrates or which yield carbohydrates during the process of digestion. Lable the approximate carbohydrate content of each one of them.
2. Ask a number of people if they would acquire any sugar in case they avoided refined sugar in all forms. How many are aware that other forms of sugar exist or that starch is converted into sugar during digestion? How many are not aware that they get quantities of sugar directly or indirectly from the food they eat?
3. List all the foods you have eaten in twenty-four hours. Mark each one which contributes any form of carbohydrates. If one food contains several types of carbohydrates, it will be necessary to list what they are.
4. The table on page 33 may be interpreted as grams of carbohydrate in 100 grams of food. By using the large tables on pages 442–465, change the 100-gram portions into household measurements and calculate the sugar in teaspoonfuls in each, counting 5 grams per teaspoonful.

5. To fix clearly in your mind the fate of carbohydrates in the body, study the graph on page 30. Outline in your notebook a similar graph and fill in the names of the nine carbohydrates listed. Then close the textbook and list as accurately as you can the sources of each carbohydrate, how they are broken down during digestion, and in what form they enter the blood.
6. To fix clearly in your mind the fate of sugars in the body, study the graph on page 31. Then close your textbook and reproduce the graph as accurately as possible in your notebook.

Topics for Discussion

1. How many sugars enter the blood unchanged? How many must be broken down in digestion?
2. Which carbohydrates yield glucose during digestion? From what additional substances can glucose be formed in the body?
3. Which sugar is used by the muscles in producing energy? Why can herbivorous animals obtain energy from cellulose?
4. Suggest foods which are desirable because of their natural sugar content.

Chapter 4

YOUR NEED FOR FAT

Fats, together with sugars, serve as a source of energy for the body. They are especially important in giving one a feeling of satisfaction during his meals. People on fat-free diets suffer much more keenly from hunger than those who can eat a liberal amount of fat.

During a food shortage, in time of war or famine, people crave fats particularly. Toward the end of World War I, a German boy obtained lard from an American prisoner. He told how he scooped it up in his hands and said that it tasted better than any other food he had ever eaten.

Sources of fat. Pure fats, such as lard, butter, or any of the oils, contain about one hundred calories per tablespoonful. Whether from animal or vegetable sources, they are equally valuable in supplying energy.

Fats rarely, if ever, occur alone in nature. Pure fats are extracted from the protein and carbohydrates of plants or animals. With the exception of fruits and vegetables the majority of natural foods we eat contain fats. The principal sources of fats are:

Animal		*Vegetable*	
bacon	cod-liver oil	almonds	corn oil
butter	fat fish	avocado	cottonseed oil
cheese	fat meats	Brazil nuts	olive oil
cream	lard	butternuts	peanuts, peanut oil
egg yolk	salt pork	soybean oil	pecans

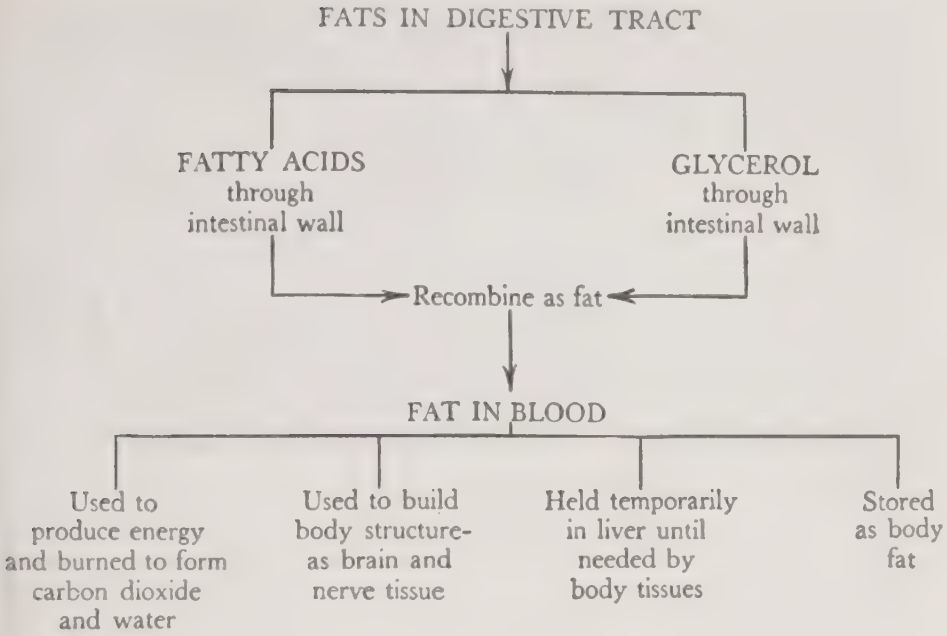
Chemical composition of fats. Like carbohydrates, fats are composed of *carbon, hydrogen,* and *oxygen.* They are made up of *glycerol* combined with three molecules of *fatty acids.* They are broken down during digestion to fatty acids and glycerol. When fats become rancid, fatty acids are freed and give off the characteristic odor of rancidity. Glycerol and fatty acids also break apart when fats are heated at high temperatures.

Fats in nature differ widely, depending upon the kinds of fatty acids which go to form them. Some, which have high melting points, are solid at ordinary temperatures. Others are liquid, or oils. These oils can be hardened by the addition of hydrogen to form the solid cooking-fats now widely used. These cooking-fats are just as easily digested as natural fats, but not more easily.

Fate of fats in the body. During digestion, fats are broken down into glycerol and fatty acids by enzymes secreted in the pancreatic and intestinal juices. Fatty acids cannot pass alone through the intestinal wall but must first combine with substances secreted in the bile. This combination causes the fatty acids to be extremely soluble and to pass readily into the wall cells of the intestinal tract. In cases where the quantity of bile which flows into the intestine is small, few fats reach the blood.

Glycerol from digested fats passes simultaneously into the cells of the intestinal walls where it again combines with fatty acids to form fat. This fat is characteristic of the human body and differs from food fats.

Fat is not dissolved in the blood or lymph, as are sugars, but is carried as tiny droplets. Following a meal, as fat enters the blood, rather large amounts are withdrawn by the liver for use in the near future. If so much fat pours into the blood that it can neither be withdrawn by the cells or stored temporarily by the liver, it is stored as body fat. This fat, like

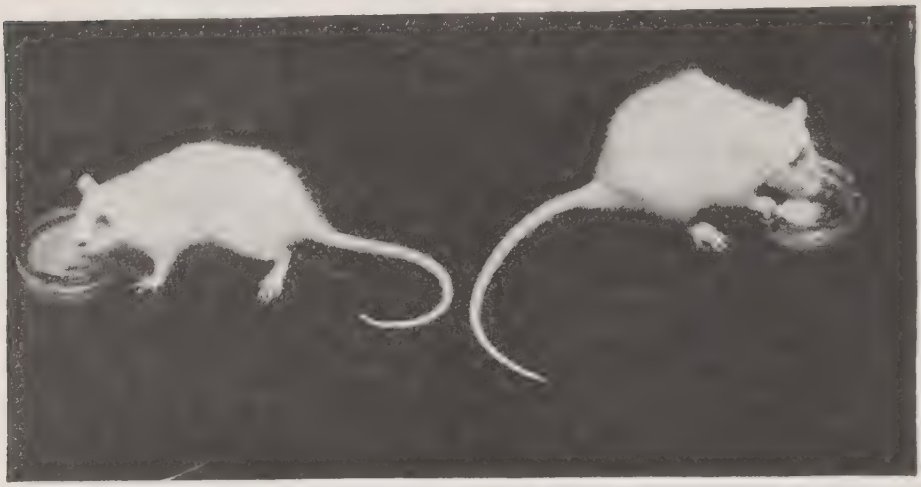

FATS IN DIGESTIVE TRACT
FATTY ACIDS through intestinal wall
GLYCEROL through intestinal wall
Recombine as fat
FAT IN BLOOD
Used to produce energy and burned to form carbon dioxide and water
Used to build body structure- as brain and nerve tissue
Held temporarily in liver until needed by body tissues
Stored as body fat

The fate of fats in the body.

that which is formed from glucose, can never be changed into sugar.

The largest amount of storage fat is deposited directly under the skin. Fat is also stored around the kidneys, liver, and heart. A thin layer of fat under the skin protects the muscles and nerves, whereas that around the kidneys gives them support. A small amount of reserve fat is also valuable as a source of energy to be used when sufficient food cannot be eaten. Such fat has often saved the lives of people during serious illness or in times when food could not be obtained. But, fat stored in excessive amounts is definitely undesirable.

Functions of fat in the body. The chief function of fat is that of serving as both an immediate and a future source of energy. As we will see later, food fats are carriers of vitamins A, B_6 (pyridoxin), D, E, and K. Aside from being excellent sources of calories, fat has many other functions in the body.



These two rats are littermate sisters, fed identically except that the smaller animal was given no essential unsaturated fatty acids. Notice the difference in size and the rough hair and scaly skin on the feet and tail of the smaller animal.

Fat combined with phosphorus is an essential component of every body cell, and makes up part of the actual body structure, particularly in the nerves and brain tissues. If you have ever eaten brain, you will recall the large amount of fat it contains.

Fat forms a part of the walls of the cells throughout the body. These walls are not separate membranes but are really a thickening of substance, like the top of a chocolate pudding which has stood a few hours. The fat content of cell walls may be illustrated by the fact that snake venom contains a substance which breaks down the fatty part of the cell-covering of the red corpuscles. This breakdown allows the contents of the corpuscles to be freed into the blood-stream to such an extent that death may result.

Certain fatty acids, known as unsaturated fatty acids, are essential to man. Without them a scaly skin rash develops. These essential fatty acids were for a time spoken of as *vitamin F*. They are generously supplied in peanut, olive, corn, linseed,

and cod-liver oils but are not rich in cream and butter. Skin conditions, such as eczema and other rashes, particularly in babies (to whom vegetable oils are usually not given) have been found associated with too few of these fatty acids in the blood and have been corrected when oils were fed. These substances are likewise necessary before the body can store fat and should be consumed in generous amounts by anyone who desires to gain weight.

Characteristics of body fat. If given more food than needed to produce energy, each animal stores a body fat which is characteristic of its own species. As you know, beef tallow differs from chicken or mutton fat. The differences actually lie in the kinds of fatty acids formed by each animal in making body fat from excess food.

When extremely large amounts of fat are fed to animals, the fat may be stored in the body unchanged. For example, the Pure-Food Administration discovered that a certain sample of lard had apparently been adulterated with peanut oil. The meat packers who had made the lard were righteously indignant and contended that they had not adulterated it. Nevertheless, analysis showed a rather high percentage of peanut oil. In the end, it was discovered that hogs fattened in the southern states had been fed such quantities of peanuts that they had stored the fat in their bodies unchanged.

Completeness of fat digestion. Fats which are liquid at body temperature (98.6° F.) are quite completely and, contrary to public opinion, easily digested. The best examples are oils, butter, and cream. Those fats which do not melt at body temperature, as tallow, are very poorly absorbed, and many are lost by way of the large intestine.

Frying at high temperatures causes fat to break down and form substances which are irritating to the walls of the alimentary tract. Frying at moderate temperatures, though caus-

ing a loss of somewhat more vitamins than do other cooking methods, does nothing more than to coat the food with a layer of fat, which can be easily digested by the healthy person.

Mineral oil is occasionally used for frying foods and for making salad dressings. It is often given as a laxative. Although this oil is a fat, the body lacks enzymes to digest it. For that reason mineral oil cannot pass through the intestinal walls into the blood and serve as a food. However, the fat-soluble vitamins A, D, E, and K are easily dissolved in mineral oil. If the vitamins are in the intestinal tract at the same time as mineral oil, they are held in the indigestible oil and are wasted through excretion in the feces.

Relation of fats to other body requirements. Fats increase the absorption of calcium by combining with it to form soluble calcium compounds, which pass readily into the blood. When no fats are given in the diet, much calcium is lost by way of the large intestine. The disease known as rickets, in which too few minerals are deposited in the bones, can be produced experimentally merely by giving a diet so low in fat that calcium does not reach the blood. On the other hand, if so much fat is eaten that it cannot all be digested, the excess fat, combined with calcium, is lost by way of the large intestine. In this way a diet too high in fat can rob the body of needed calcium.

The more energy produced from fats, the less sugar burned. Since, as we will see later, the function of thiamin (vitamin B_1) is to aid the body in burning sugar to produce energy, the more fat eaten, the less thiamin needed. Fats, therefore, have a sparing action on thiamin. In the production of energy by the body, fats are burned before proteins are. For this reason, fats serve as a sparer, or conserver, of body protein in times of fasting or starvation.

The amount of fats needed. No one knows the ideal amount of fat needed in the diet. The amount actually eaten varies

widely with the individual, and undoubtedly individual needs also vary. Except with the overweight person who has fat already stored in the body, the diet must never be completely devoid of fat.

Fat is not only a source of energy, but it also enters actively into the structure and life processes of the body.

Project

1. Write down all the foods you have eaten in twenty-four hours. Mark those which have contained at least some fat.
2. Make a list of foods which contain essential fatty acids.
3. To fix clearly in your mind the fate of fats in the body, study the graph on page 39. Then close your textbook and reproduce the graph as accurately as possible in your notebook.

Topic for Discussion

1. Name the uses of fat in the body. Could a person live entirely without fat? What type of fat would be best to eat if you wished to gain weight? Why? Do you see any reason why extremely rich milk would ever be undesirable?
2. Why is it best never to use mineral oil internally? Why does one fat differ from another? What part does bile play in the absorption of fat? Why are lamb chops often recommended on reducing diets?

Chapter 5

PROTEINS, THE BUILDERS AND REPAIRERS

Aside from water, protein makes up the largest proportion of the body or about 18 per cent by weight. Hair, nails, skin, and muscle tissue consist almost entirely of protein. It is so essential to all living cells as the basis of their structure and living matter that without it life cannot exist.

Sources of proteins. Proteins occur in nature together with fats and carbohydrates and rarely, if ever, alone. The purest forms of natural proteins are found in egg white, the curd of milk, and fat-free meats. Plants can synthesize, or make, their own proteins, but animals must obtain theirs from foods.

Aside from living tissue, proteins are stored by nature only when they are necessary for the development of new life, such as the young of animals and the seeds of plants. This rule can help you to remember the food sources of protein: those, such as eggs and milk, designed to support young life; those which in their natural state are seeds, such as nuts, beans, peas, legumes, and cereal grains; and those which come from living tissue, such as meat, fowl, or fish.

Variety of proteins. Proteins are made up of substances called *amino acids.* Twenty-three of these amino acids are known, different from one another, but similar in that all contain nitrogen which is lacking in fats and carbohydrates. Two amino acids contain sulfur, and two, which occur in very few proteins, contain iodine.

In the same way that thousands of words are made from the twenty-six letters of the alphabet by combining different let-

ters, so are thousands of proteins made of different combinations of amino acids. The proteins in milk differ from the proteins in wheat, because the number and kind of amino acids used to make up these proteins are not the same. The proteins in the body also vary widely for the same reason and that of the liver is unlike that of the muscles. Proteins such as those in egg white (*albumin*) or milk (*casein*) contain combinations of several hundreds or even thousands of the individual amino acids. They are as complex as would be a single word if it were made up of hundreds or even thousands of letters.

Proteins used for building and repair. When foods containing protein are eaten and digested, the proteins are broken down by enzymes into the amino acids of which they were originally made. These amino acids dissolve in water just as sugar does. They pass into the blood stream and are carried to every cell in the body so that the cells can withdraw the amino acids they need. These amino acids are used as the building blocks to construct new body tissue throughout the entire growth period from the very beginning of life to complete adult development. Not only are muscles, hair, nails, and skin made of protein; it also forms the structure and living matter of the cells which make up the liver and kidneys, the nerves and the brain, the ligaments and cartilage, the cartilage-like foundation of the bones, and the walls of the blood vessels and digestive tract. In short, all body tissue is made of protein just as a house might be made of bricks. In the same way that new bricks are added when the house is being built, so are new proteins formed and added to the body structure throughout the process of growth. It is obvious, then, that proteins must be generously supplied in the diet during the entire growth period, so that the amino acids may be available for the building of body tissue.

Just as bricks in a house might crumble and need to be re-

placed, so do the proteins in the tissues wear out and need to be replaced by fresh proteins. In this case, the worn tissues are broken down by enzymes in the cells, and the waste products, which can dissolve in water, are carried in the liquid part of the blood to the liver. Here nitrogen and sulfur are removed by enzyme action and taken by the blood to the kidneys to be thrown off in urine. The remaining part of the amino acids is then changed into either fat or glucose to be used for energy.

Scientists can analyze the urine for the nitrogen-containing waste products of worn-out proteins, and are thus able to tell how much of the body tissue is being replaced at any one given time.

As the worn-out proteins are broken down and their waste products carried away, the cells from which they came withdraw amino acids from the blood. By the help of enzymes in the cells, the amino acids are combined to form new proteins, a process which is the reverse of the breakdown of proteins by enzymes in the digestive tract. Whereas food proteins are needed for growth only until maturity, proteins are needed for repair throughout life because the repair of worn-out tissues goes on from birth until death. Since the adult is much larger than the child and therefore has more tissue to be repaired, the need for generous amounts of protein in the diet continues throughout life.

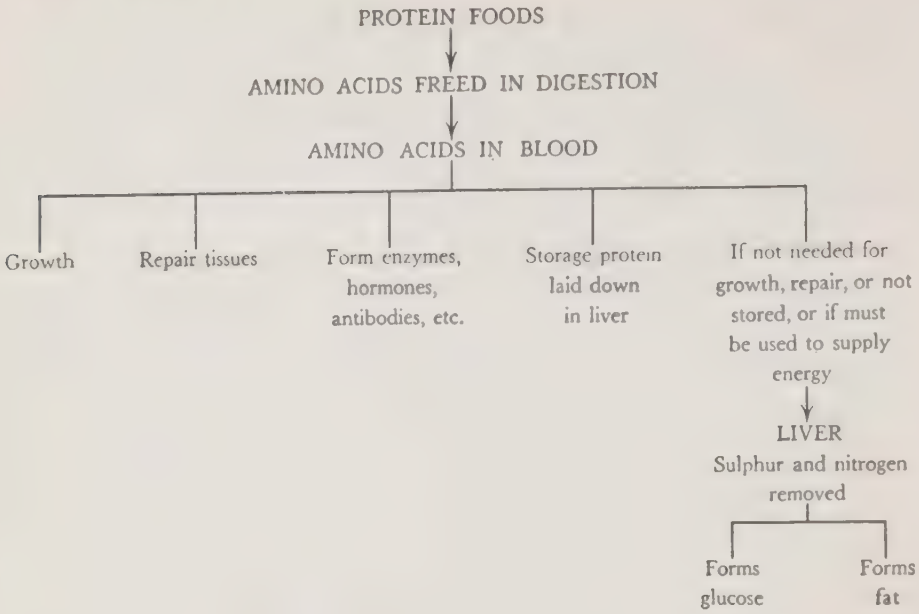
When a generous amount of protein has been eaten, more amino acids pour into the blood than can be used immediately for growth or for building and repair. In this case, the liver withdraws amino acids from the blood and stores them in the form of *storage protein*. As the cells throughout the body use the amino acids in the blood for building and repair, the supply is replenished by amino acids from the breakdown of storage protein in the liver. The amount of amino acids in the blood, therefore, is kept relatively constant both directly after meals

and when no food is being absorbed. As long as the diet is adequate, amino acids are therefore always available.

If no food is eaten, as during starvation, storage proteins are used for building and repair. If they do not supply the amino acids needed, these acids are taken from the least important muscles.

Proteins used for energy. The liver can lay down only a limited amount of storage protein. If so much protein foods are eaten that they can be used neither for growth, building and repair nor stored in the liver, the excess is withdrawn from the blood by the liver. In this case, instead of being stored, nitrogen and sulfur are broken off and are carried to the kidneys to be excreted in the urine. The remaining portion of amino acids, some of which are then chemically similar to sugar, are changed into glucose; others, which without nitrogen and sulfur, are similar to fatty acids, are built into fats. When proteins are eaten in excess of body needs, therefore, they are used in the form of either fat or glucose to produce energy. If proteins are eaten in such quantities that they are not needed for building, repair, storage, or for energy, the fat and glucose formed from the amino acids are stored as body fat for future energy. Also, as we have seen, the remaining portion of amino acids from worn-out tissue is likewise used for energy.

If fats and carbohydrates are not eaten in sufficient amounts to supply all the energy needs of the body, proteins must be used for this purpose. A diet high in protein but so low in fat and carbohydrate that protein must be used for energy is undesirable because of the by-products which must be thrown off by the kidneys. Foods like meats, eggs, and milk are more expensive than fats and carbohydrates, which the body uses to produce energy more efficiently than it does proteins. To use proteins as a source of energy is as extravagant as to burn olive oil in your oil heater.


PROTEIN FOODS
AMINO ACIDS FREED IN DIGESTION
AMINO ACIDS IN BLOOD
Growth
Repair tissues
Form enzymes, hormones, antibodies, etc.
Storage protein laid down in liver
If not needed for growth, repair, or not stored, or if must be used to supply energy
LIVER
Sulphur and nitrogen removed
Forms glucose
Forms fat

The fate of proteins in the body.

If no food is eaten, there are three sources of energy: fat which has been stored on the body supplies the principal source; the storage fat is supplemented by the glucose and fat from the protein of worn-out body tissues, which is used as the wear and tear occurs, and by storage protein, which the body conserves and therefore burns very sparingly. When fat is the principal source of energy the amount of nitrogen excreted in the urine, which can come only from protein, is small. If the supply of storage protein and body fat has been exhausted, the body tissues themselves, made of protein, are used for energy. In this case, the amount of nitrogen excreted is greatly increased. Although amino acids from the least important muscles are first used for energy, and those of the vital organs such as the heart are preserved, the increase in nitrogen in the urine occurs just before death from starvation.

Other functions of protein. Aside from growth, repair, and the production of energy, the body uses protein in many other

ways which are of tremendous importance to health. For example, *hemoglobin,* the iron-containing material in the red corpuscles of the blood, is largely protein. The *hormones* produced by the glands throughout the body are made of proteins. Enzymes are largely proteins. Proteins are responsible for the collection of urine and the removal of wastes through the kidneys; they help to prevent the blood and fluids bathing the tissues from becoming either too acid or too alkaline. Proteins are of tremendous importance in the clotting of blood. They also form substances in the blood known as *antibodies,* which combine with bacteria, with harmful by-products of bacterial activity known as *toxins,* and with any other foreign materials which reach the blood. In these ways, proteins are again so essential that life cannot exist without them.

Finding the amino-acid needs. When a single protein, such as one from milk, eggs, beans, or corn, is fed to experimental animals as the sole source of amino acids, this protein may produce growth and health but it may not. Even when a protein which cannot support growth alone is given together with another protein which also cannot support growth, growth often results. Scientists, by studying the amino acids which make up the various proteins, have found that certain amino acids are essential to growth while others are not, and that some proteins lacked these essential amino acids which others contained. In the case of a mixture of proteins, neither of which produced growth alone, one protein supplied the amino acids lacking from the other.

Scientists have now learned how to synthesize (to make) amino acids in the laboratory which are identical to those produced in nature. Experiments have been carried on, especially by Dr. Rose at the University of Illinois, in which rats were fed, as their only source of protein substance, these synthetic amino acids. Some animals, given only a few amino acids,

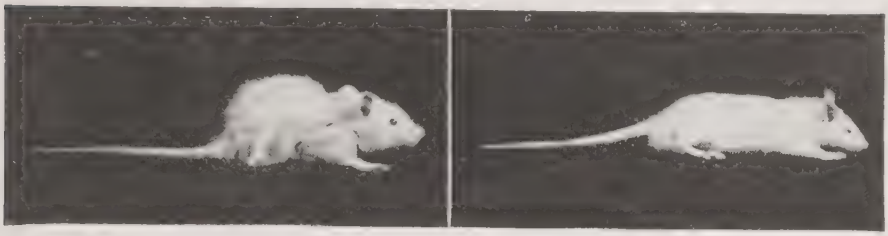
failed to grow and soon died. Other animals were given additional amino acids, and the results were noted. In this manner, it was found that if a particular combination of ten amino acids was given, the animals remained healthy. If other amino acids aside from these ten were given, they were used in the animal to build protein, but if they were not given, the animal body used the nitrogen and sulfur provided by the ten essential amino acids and made, in its own body, the remaining amino acids needed to build and repair tissue.

Making amino acids in the laboratory is a tedious, difficult, and expensive process. The amount of such amino acids fed during a single experiment to a few rats for only two weeks has cost as much as fifty thousand dollars. It was not until such experiments were carried out, however, that it was understood which of the amino acids are essential to life and which of them can be made in the body.

Ten essential amino acids. Since of the twenty-three amino acids, all but ten can be synthesized, or made, in the body itself, these ten which cannot be made are spoken of as the *essential amino acids.* If a person is to remain healthy, these ten essential amino acids must be obtained from food. *They are as important to life as are the vitamins.* The need of protein, therefore, resolves itself into a need for individual amino acids.

A protein food is of much or little value depending on the number and quantity of essential amino acids it contains. Proteins containing all ten of the essential amino acids in generous amounts are called *complete proteins,* or proteins of high biological value. When a complete protein is fed to young animals as the only source of protein, normal growth and development result.

A protein which lacks one or more of the essential amino acids, or supplies such a small amount of an amino acid as not to be able to support growth, is spoken of either as an *incom-*



These rats are littermate brothers which have been given exactly the same diet except that the animal at the left has not received one of the essential amino acids. Notice the condition of the fur and the hunched position.

plete or an *inadequate protein* or one of low biological value.

The nutritive value of proteins. The proteins of eggs and milk have the highest value. The proteins in glandular meats such as liver, kidneys, and pancreas, rank second in value and contain all the essential amino acids in abundance. Proteins from muscle meats (roasts, steaks, and chops) are complete but contain fewer of some of the essential amino acids than do glandular meats and are therefore of less value. For the same reason, proteins from animal sources such as meat, fish, eggs, milk, and cheese are in general of greater value to the body than those from vegetable sources. Egg white and gelatin, however, each lack several essential amino acids.

Proteins from nuts, soybeans, wheat, especially wheat germ, and cottonseed flour and meal are complete proteins. Other vegetable proteins, such as those in peas, corn, and navy and lima beans, lack some of the essential amino acids and are therefore incomplete. They cannot support life alone, but if taken in a mixed diet, one protein supplies the amino acids lacking in another, and together they make a valuable contribution to health. To achieve health, therefore, both the quality and the quantity of proteins eaten must be considered. Of the two, the quality of protein eaten is probably of greater importance than the quantity.

LIBRARY

Projects

1. List the amount of all foods you have eaten in the last twenty-four hours. From what foods have you obtained protein? Classify the proteins as complete or incomplete.
2. By using the tables on pages 442–465, compute the grams of protein you have eaten in one day.
3. To fix clearly in your mind the fate of protein in the body, study the graph on page 48. Then close the textbook and reproduce the graph as accurately as possible in your notebook.

Topics for Discussion

1. What are the uses of protein? Why is it extravagant to use protein for energy? When protein is used for energy what waste products are formed compared to those resulting from the burning of carbohydrates and fats?
2. What two rules can you keep in mind to help you remember the sources of proteins?
3. Since all twenty-three amino acids are essential to life, why are ten called the essential amino acids? What two amino acids are absent from most proteins? Can a food contain all ten essential amino acids and still be incomplete? Why? How can incomplete proteins serve as complete proteins?
4. Name protein foods in order of their greatest value to the body. Why is one protein different from another?
5. What are the sources of protein used for energy: when too little carbohydrate and fat are eaten? when no food is eaten? when starvation becomes advanced?
6. If no food is eaten, where are the amino acids obtained which are needed for repair? During starvation, if nitrogen excretion is greatly increased, what does this fact prove? What happens when essential amino acids are neither obtained from foods nor are available from storage protein?
7. If more protein is eaten than is needed for building and repair, how is it used by the body?

Chapter 6

PROTEIN DEFICIENCIES AND REQUIREMENTS

Most people know that meat, eggs, milk, cheese, and meat substitutes supply protein, but they know little about the quality of proteins and almost nothing about the quantity needed. The average person thinks that if he eats a serving of meat daily, he gets enough protein.

Although every person in our country could easily obtain adequate protein to build health, studies have shown that 60 to 80 per cent of Americans are deficient in this nutrient. Milk, eggs, meat, and cheese are the most expensive items on a food budget, and the first to be decreased or eliminated when money is scarce. Millions of adults allow coffee, tea, and alcoholic beverages to crowd out milk. Thousands more avoid milk, cheese, breads, and cereals for fear of gaining weight. The chief causes of protein deficiencies, however, are ignorance and carelessness. The results are untold man-hours of inefficiency and a tremendous amount of needless suffering.

Studies in protein needs. Research in the value of proteins received great impetus during the second World War. Soldiers suffering from severe wounds and burns made remarkable recoveries after being given quantities of blood plasma. But when the men were given sterile water containing the same amount of salt, glucose, vitamins, and minerals as contained in plasma, they failed to respond. When proteins from the blood plasma were given, however, rapid healing resulted. Since plasma was difficult to obtain, methods were devised for breaking down the adequate proteins of milk or soybeans to

amino acids which could be injected directly into the blood. The larger the amount of amino acids given, the more rapid were the recoveries.

During and following the war, thousands of studies were made of the needs for proteins in the body. These studies showed that the value of adequate protein was far greater than had heretofore been appreciated.

Protein and attractiveness. One of the signs of protein deficiency seen so frequently among high-school students—and teachers—is faulty posture. All muscles are made of proteins. The proteins of every muscle in the body contain all the essential amino acids. When the diet is entirely adequate, the pull of strong muscles holds the body erect without conscious effort. If the diet does not supply all the essential amino acids in adequate amounts, the muscles lack tone and may even become soft and flabby. The most expensive and attractive clothes do not show off to advantage when the shoulders are rounded, the abdomen protrudes, or the head is held forward rather than high.

Hair and nails are also made of proteins which contain essential amino acids. Their particular need is for the sulfur-supplying amino acids found in egg yolk. If these amino acids are deficient in the diet, the nails break easily; the hair lacks luster and beauty.

Poor posture and unhealthy nails and hair are seen in malnourished children of all ages, are common among adults, and are almost universal among elderly people, whose diets have been inadequate in protein over so many years that their muscles are likely to be extremely soft and flabby. If you wish to be attractive and to remain so throughout the years to come, see that your diet supplies ample proteins of high quality.

Relation of protein to fatigue. The person whose diet fails

to supply adequate protein soon suffers from fatigue and lack of endurance. When glucose and fat are burned to produce energy, they are changed to carbon dioxide and water. This change involves many steps which are made possible by enzymes, similar to the digestive enzymes in the stomach and intestine. Enzymes are made of protein which contains essential amino acids. Studies have shown that when these essential amino acids are undersupplied, fewer enzymes are produced. Energy cannot therefore be liberated normally, and listlessness and fatigue result.

Persons whose diets are deficient in protein have been found to develop anemia, or lack of red blood cells; invariably they suffer from fatigue. Red blood cells, which carry oxygen throughout the body, are made of protein. This protein, in turn, contains essential amino acids and cannot be formed unless these acids are furnished in the diet. If even one of the essential amino acids is not obtained in adequate amounts, the red blood cells cannot be produced in sufficient numbers to supply the body with the oxygen it needs. In efficiency, foggy thinking, and lack of energy quickly follow.

Another state of fatigue, when proteins are undersupplied, is brought about by a lowering of blood pressure. The walls of all blood vessels, including the thousands of miles of capillaries throughout the body, are made of protein. Just as the muscles lose strength, or tone, when the diet is inadequate, so do the blood-vessel walls lose strength; hence they enlarge, or stretch. The amount of blood in the body actually decreases as a result of insufficient protein intake. A decrease in the volume of blood flowing through enlarged blood vessels reduces the force, or push, against the blood-vessel walls. Plasma, which carries oxygen, glucose, amino acids, vitamins, and minerals, is not forced strongly enough into the tissues. The cells, undersupplied with nutrients, cannot produce energy

normally. Since the blood vessels are most relaxed during the night, the person is so tired that he finds it difficult to get out of bed.

When a diet high in protein of good quality replaces one low in protein, the blood pressure becomes normal, and more red blood cells and energy-releasing enzymes are produced. A feeling of energy and well-being crowd out listnessness and fatigue.

Relation of protein to infections. It has long been known that when proteins are undersupplied, as during wars or famines, entire populations become susceptible to infections. In Europe following both World Wars, tuberculosis, diphtheria, rheumatic fever, and pneumonia became rampant. Colds and infections of the sinuses, mastoids, ears, and intestines increased both in number and severity.

In our country, there are today over a half-million children who face life with damaged hearts because of rheumatic fever, and each year thousands more are afflicted. A recent study made of the diet served in two boarding schools throws light on the cause of this needless suffering. In one school the children contracted frequent infections of all types; there were many cases of rheumatic fever. In the other school, the children were singularly free from infections and none suffered from rheumatic fever. An analysis of the diets showed that they differed significantly only in the kind and amount of protein served. The healthy children had received a diet high in protein of good quality.

The body has two forms of defense mechanisms which normally help to protect it against infections. Throughout the body are cells known as *phagocytes* which have the power to engulf and digest bacteria and other foreign material which get into the tissues and blood. Phagocytes are made of protein which contains essential amino acids. If you eat too little

protein or if one or more of the essential amino acids are undersupplied, few bacteria-fighting cells can be produced. Any bacteria entering the body have free range and are allowed to multiply; infection or disease likely results.

The body's second line of defense is in the production of substances known as *antibodies*. As soon as bacteria enter the body, the liver produces antibodies which destroy them or render them harmless. Antibodies are made of protein which contains essential amino acids. Experiments have shown that in case the amount of protein in the diet falls below normal or is deficient in an essential amino acid, few antibodies are produced and the ability of these few to destroy bacteria is greatly decreased. It has been found that when a high protein diet is eaten by a person whose protein has been inadequate, a hundred times more antibodies are produced within a single week following the dietary improvement.

If you wish to stay free from infections and infectious diseases, you must see that your diet supplies ample protein of high quality. If you develop an infection, your first thought must be that of obtaining high-quality proteins which can be used in producing phagocytes and antibodies.

Relation of protein to digestion. When the protein in the diet is inadequate, various abnormalities occur which cause food to be less completely digested. The walls of the stomach and the small and large intestines are made of circular muscles. These muscles can maintain their strength only if the diet supplies all the essential amino acids. When the diet is inadequate, the flabby muscles cannot contract normally; the food is not well mixed with digestive juices and enzymes nor is digested food brought into contact with the absorbing surface of the intestinal wall. Food is left undigested. Bacteria in the intestines thrive on the undigested food, causing gas pain and distention. The problem is further exaggerated be-

cause digestive enzymes, made of protein which contains essential amino acids, decrease both in number and effectiveness. The cells of the intestinal tract also become waterlogged, a condition which interferes with the absorption of food. Studies have shown that persons deficient in protein have slow emptying of the stomach and small and large intestine. Slow emptying of the large intestine results in constipation.

The person who suffers from indigestion and constipation does not feel well; usually he eats less protein instead of increasing his intake. Probably he takes cathartics which not only force food through his body before it can be digested but also irritates the intestinal walls. Thus his condition becomes worse rather than better.

In cases where food is not well digested, the first thought should be of increasing the protein in the diet. This protein should be of such high quality that digestive enzymes would be produced in normal quantities and the muscles of the digestive tract would become strong and elastic.

Relation of protein intake to ulcers. Experiments with rats and dogs have shown that if the animals are kept on a diet inadequate in protein, 100 per cent develop ulcers of the stomach or the upper part of the intestine known as the *duodenum*. Similarly, persons having stomach and duodenal ulcers are found to have lived on diets inadequate in protein. Even when ulcers in humans have healed, they quickly recur if too little protein is eaten. In the past, when ulcer patients were given a diet supplying about 40 grams of protein daily, healing was extremely slow. Studies have shown that when 200 to 250 grams of protein are obtained daily by the ulcer patient, healing is greatly accelerated. If the high-protein diet is continued, ulcers rarely recur.

Ulcers of the skin are also found to result when the diet is low in protein, but they can be quickly healed when generous

amounts of adequate protein are eaten. The skin is made of protein which contains the essential amino acids; hence healing cannot occur until all of these essential amino acids are amply furnished in the diet.

Protein and strength of bones. The basic substance of all bones, which holds the minerals in place, is made of a tough protein similar to cartilage. Like other proteins of the body, it requires essential amino acids if it is to stay strong. Experiments with animals show that bones fracture or break easily whenever protein is undersupplied in the diet. Similarly, it has been found that persons whose bones break easily give a history of having eaten few protein foods. There is little doubt that one reason why the bones of elderly persons break so readily is that they frequently live on a diet of tea, toast, soft fruits, and vegetables.

When high-school boys suffer fractures or broken bones while playing football or basketball, in all probability their diets have not supplied sufficient protein to meet the needs of rapid growth.

Protein and the healing of wounds. Whenever the body suffers any type of wound, whether from surgery, a burn, broken bones, or fractures, large amounts of body protein are destroyed. By measuring the nitrogen lost in the urine, scientists can determine the extent of this destruction. For example, in one case following surgery, 156 grams of body protein were destroyed daily, and this loss continued for six weeks. It is believed that protein from the least important muscles is torn down in order to free essential amino acids needed in rebuilding tissues, or healing the wounds; nitrogen is removed from the other amino acids of the destroyed protein and thrown off in the urine. If a diet extremely high in protein can be taken, the destruction of body protein is largely prevented.

The speed of healing and the strength of scar tissue are found to be in direct proportion to the amount of adequate protein in the diet. Surgical incisions are likely to break open again and again when the protein intake is low. If the diet is poorly chosen, even a small scratch or cut is often slow in healing. Since the body's defenses against bacteria are low at such a time, infection may set in. Slow healing and reinfection are often observed among high-school students suffering from pimples which they pick or scratch.

In case of any injury which involves rebuilding of body tissues, the diet should supply the maximum amount of high-quality proteins that the patient is able to tolerate. For severe injuries, physicians now recommend as much as 300 grams of protein daily.

Severe protein deficiency. The conditions already considered are results of mild protein deficiencies which can be found in varying degrees in the majority of people. If the protein deficiency becomes more severe, an abnormal amount of water is held in the body.

When the diet is adequate, the blood contains a certain amount of a protein known as *albumin*. The purpose of this protein is to attract into the blood from the tissues the fluids which contain waste materials to be thrown off in the urine. Albumin can be produced by the body only in case the essential amino acids are amply supplied in the diet. Whenever the protein deficiency is severe, the amount of albumin in the blood decreases to such an extent that fluids and wastes cannot be drawn efficiently into the blood stream. Although quarts of waste-contaminated fluids are allowed to remain in the body, the person suffering from this condition merely thinks he has gained weight. He will notice that on rising his face and hands are swollen, that there is puffiness under his eyes, and that his ankles swell during the day if he walks or stands.

This condition, known as *edema,* is common among elderly people, the poor of all ages, and even well-to-do persons who are ignorant or careless about their choice of foods. It is especially widespread during extremely hot weather; the heat causes the appetite to become so jaded that little meat, eggs, and cheese are eaten and ice tea and soft drinks take the place of milk.

Protein and clear thinking. An enzyme in the brain has been found to be made largely of one of the animo acids, known as *glutamic acid.* Since this enzyme helps in supplying the brain with oxygen, tests were undertaken to see whether intelligence could be improved by increasing the amount of glutamic acid in the diet. Rats were given glutamic acid in addition to a diet high in protein. The intelligence of the rats was tested and compared with that of other rats kept on the same diet except that glutamic acid was omitted. It was found that the animals given glutamic acid learned more quickly and were much more intelligent than those on an apparently normal diet.

After children of different ages were given numerous tests to measure their intelligence and personalities, glutamic acid was added to their diet. The tests were then repeated at intervals. They showed that not only was the intelligence of the children markedly increased as long as they took glutamic acid, but that their personalities also improved.

The richest sources of glutamic acid are milk and cheese. Every person, particularly high-school students, should have a quart of milk and a serving of cheese daily. A breakfast to be eaten on the morning before an examination might well include a large piece of cheese, perhaps melted on toast, and 2 glasses of milk.

Excessive protein intake. It was once thought that kidney injury, high blood pressure, and hardening of the arteries

could be caused by eating too much protein. Careful experiments with animals have shown these beliefs not to be true. The Eskimo, whose diet is principally protein, is singularly free from these diseases. The Arctic explorer, Stefansson, and his assistant lived for a year on meats alone. During that time there was no increase in the blood pressure of either man; nor was there any evidence of kidney disease or hardening of the arteries.

If more protein is eaten than the body needs, it is changed to glucose and fatty acids; it is either burned to produce energy or stored as fat. No harmful effects result. The problem is how to get enough protein; certainly there is no need to fear that you will get too much.

Recommended daily allowances of protein. The amount of protein needed varies with age, rate of growth, and condition of health. The Food and Nutrition Board of the National Research Council has recommended the following amounts of protein daily for healthy persons:

CHILDREN BELOW 12 YEARS	GRAMS	CHILDREN OVER 12	GRAMS	ADULTS	GRAMS
1–3	40	*Girls:*		*Women:*	60
4–6	50	13–15	80		
7–9	60	16–20	75		
10–12	70	*Boys:*		*Men:*	70
Babies: 1.4 grams per pound body weight		13–15	85		
		16–20	100		

These quantities have been so widely criticized as being too small that it is best to meet your requirement entirely by adequate protein and let the inadequate count merely for good measure. In order to obtain sufficient adequate protein, at least a half of your requirement should be supplied by animal sources: milk or buttermilk, cheese, eggs, and meat, fish, or

fowl. These animal proteins offer all the essential amino acids in larger amounts than do most vegetable proteins. Gelatin, which lacks five of the essential amino acids, and egg white are exceptions to this rule. The vegetable proteins of nuts, peanut butter, soybeans, and especially wheat germ and brewers' yeast are rich in all the amino acids.

What you should know about protein sources. The amount of protein in foods is measured in grams. The following table lists the quantity of protein obtained from most ordinary foods and from a few foods which should be adopted for general use.

FOOD	AMOUNT	GRAMS OF PROTEIN
whole milk	1 quart	32
skim milk	1 quart	34
powdered skim milk	½ cup	34
egg	1	6
brewers' yeast	1 heaping tblsp.	12
peanut butter	2 tbls.	9
cereals (oatmeal, cornflakes, *etc.*)	1 serving	2 to 5
wheat germ	½ cup	24
cottage cheese	½ cup	20
American or Swiss cheese	1 serving	10 to 12
meat, fish, or fowl	1 serving	12 to 22
macaroni, noodles, or rice	1 serving	3 to 4
navy or lima beans	1 serving	6 to 8
soybeans	1 serving	20
bread	1 slice	3
whole-wheat flour	1 cup	12
white flour	1 cup	10
soybean flour	1 cup	37
peanut flour	1 cup	60

You should thoroughly memorize the quantities of protein supplied by each of the foods listed in the above table so that you will be able to recall them at a moment's notice and without any hesitation whatsoever. If you learn nothing else from this book, know what your protein requirement is and what amounts of food are needed to meet your needs. Although it

is customary to have students memorize 100-calorie portions of food, it is a thousand times more important for your present and future health for you to know grams of protein supplied by any food rather than the calories it contains.

The tables at the back of the book show that foods not stressed here, such as fruits and vegetables other than legumes, do supply some protein. The amounts supplied are so small and, like gelatin, so deficient in many essential amino acids that they are not worth considering as part of your protein intake.

In learning the amounts of protein listed in the foregoing table, you should notice a number of facts. For example, the so-called meat substitutes, rice, macaroni, noodles, and the usual variety of beans, are actually not meat substitutes. Meat supplies two to six times more protein; it offers more of the essential amino acids in larger amounts. You will notice, however, that ordinary beans furnish twice as much protein per serving as do rice, macaroni, and noodles; that soybeans supply many times more, and they contain complete protein whereas other beans do not. Notice that 1 heaping tablespoon of brewers' yeast or 2 tablespoons of peanut butter contain more protein than does an egg; when eggs are expensive, these foods can serve as protein substitutes.

You can readily see that if a person drinks a quart of milk daily in addition to a normal diet, he is fairly sure to obtain enough protein of good quality. On the other hand, if he drinks little or no milk, the chances are that he is deficient in protein.

If you eat a half cup of wheat germ daily, you would get five to twelve times more protein than you would obtain from most ordinary cereals. Wheat germ supplies generous amounts of all the essential amino acids, whereas the protein in most cereals is incomplete.

Although a slice of bread, whether of whole-wheat or white flour, supplies 3 grams of protein, the quality of protein is by no means the same. Whole-wheat bread, which contains the wheat germ, supplies adequate protein, whereas the protein in white bread furnishes only small amounts of essential amino acids.

Notice that the daily protein requirements for boys and girls of high-school age are higher than during earlier stages of growth or during adult life. The time to apply your knowledge of proteins, therefore, is now.

Adequate protein on a limited budget. Although millions of Americans live on diets inadequate in protein because the best-known sources of this nutrient are expensive, many high-quality proteins are extremely cheap. One of the most delicious and easiest to use is powdered skim milk. This milk is identical with fresh skim milk except that the water is removed. It can be purchased from dairies, bakeries, or health-food stores. A half cup of the powder, equal to an entire quart of fresh milk, can be beaten with a pint of fruit juice, water, or fresh whole milk and thus made into a palatable drink. Large amounts of powdered milk can be used in making malted milks, cream soups, cream sauces, custards, and puddings, or can be sifted with the flour in making breads, cookies, or cake.

Soybeans can be prepared not only as stewed or baked beans but can also be made into "meat" loaf and patties. "Soygrits," or cracked soybeans, cooked quickly can be served as a cereal or added to any cereal, soup, casserole dish, or bread. When "soygrits" are mixed with nut flavoring, they make an excellent substitute for nuts to use in cookies, puddings, or nut breads.

Flours made of soybeans and of peanuts are available at little cost. Both kinds of flour are bland in flavor and can be

used in making soups, sauces, hotcakes, waffles, cookies, pie-dough, and many other foods.

Brewers' yeast, which is 46 per cent protein, offers more nutrients in a small volume than almost any other food. It can be added to gravies, breads, cookies, and soups, but is most easily taken when stirred into water, milk, or fruit juice.

All of these inexpensive foods furnish adequate proteins which supply large amounts of the essential amino acids. Recipes for using these foods can be found in the cookbook, *Let's Cook It Right*.[1] If a person once learns to use these valuable foods, he need never be deficient in protein regardless of his financial status.

Fulfilling your protein needs. The only way to assure that you obtain adequate protein is to count the grams of protein you eat daily and compare that amount with your requirement. For this reason you should know the grams of protein supplied by ordinary foods so thoroughly that you can count them mentally.

The foods listed in the following table should serve as a basis for your daily protein intake. In all probability you will

FOOD	AMOUNT	GRAMS OF PROTEIN
milk	1 quart	32
egg	1	6
cheese	1 serving	12
meat, fish, or fowl	1 serving	12 to 22
wheat-germ cereal	¼ cup	12
bread	2 slices	6
		80 to 90

eat more bread and cereal and perhaps have a peanut-butter sandwich or a meat sandwich for lunch in addition to a serving of meat for dinner.

[1] Adelle Davis, *Let's Cook It Right*. New York: Harcourt, Brace and Company, 1947.

If you wish to reduce, increase rather than decrease your protein intake. Proteins are most nourishing and keep your appetite satisfied. Substitute skim milk for whole milk. Increase cottage cheese to a half cup daily. Have your egg poached or boiled, the meat broiled or roasted. Instead of bread and cereal, substitute 2 or 3 heaping tablespoonfuls of brewers' yeast stirred into milk, water, or fruit juice.

If you wish to build and maintain your health, see that your diet is adequate in proteins of high quality now and throughout all the years to come.

Case History

Mrs. M. L., a well-to-do woman in her late thirties, thought that she ate quite sensibly. She made a point of having several fruits and vegetables and two large green salads daily because she knew they were good for her. Since her weight was a problem, she carefully avoided milk, cheese, bread, and cereals. But she could not resist sweets and she "just loved" cola drinks. Meat did not appeal to her and she disliked eggs and fish.

She had not felt well for some time. Every task seemed such an effort, and the fatigue in the morning, before she drank several cups of coffee, was almost more than she could endure. One severe cold had followed another. She had suffered from bouts of indigestion for years, and could not remember when she had not used cathartics. Her soft, flabby muscles and poor posture worried her. For the past 6 months her hands had been swollen in the morning, and there were unsightly puffs under her eyes; by evening her ankles were usually twice their normal size.

When she visited her physician, he pointed out that her trouble was caused largely by lack of protein and that she should eat meat. She co-operated by having bacon for breakfast and a slice of meat for lunch in addition to meat for dinner. She failed to realize that what she considered to be an extremely high protein diet probably supplied no more than 35 grams. Since she felt no better when she next visited her physician, he gave her a chart of protein quantities and asked her to get 150 grams daily, adding

skim milk, cheese, eggs, and brewers' yeast to her diet. She made marked improvement, lost 15 pounds, and was soon telling her friends that she felt like a different person.

Projects

1. Make a list of proteins eaten in one day by a child, a man, a woman, and an elderly person. Mark the proteins as complete or incomplete and compare the intake with the requirement of each individual. Tabulate the findings of the class on the blackboard. Have the women eaten less protein than the men? Do you find that elderly persons usually eat too little protein? What suggestions can you make for improving the diet of these people?
2. Plan a day's protein intake supplying 150 grams of protein for a high-school athlete who has suffered a fractured leg; another supplying 200 grams for a badly burned child; one for a vegetarian who requires 80 grams of protein but who eats no cheese, eggs, or milk. Be sure that the quantities are not too large to be eaten comfortably.

Topics for Discussion

1. How can a lack of protein result in: low resistance to infections? indigestion? fatigue? slow healing? unattractiveness? decreased strength of bones? a tendency to ulcers? a gain in weight?
2. At what time during the life span are the requirements of protein highest? Why? Under what conditions might a person require 200 grams of protein daily.
3. How many grams of protein would be supplied by a glass of milk into which was beaten a half cup of powdered skim milk? By a half cup of wheat germ added to a half cup of cornflakes? By a serving of cream soup containing 8 ounces of fresh milk, into which was stirred ¼ cup each peanut flour and powdered skim milk? By "candy" made by mixing a half cup each of honey and peanut butter (8 tablespoonfuls) and 2½ cups of wheat germ?
4. How much milk would be required to supply the protein requirement of a 15-pound baby?

Chapter 7

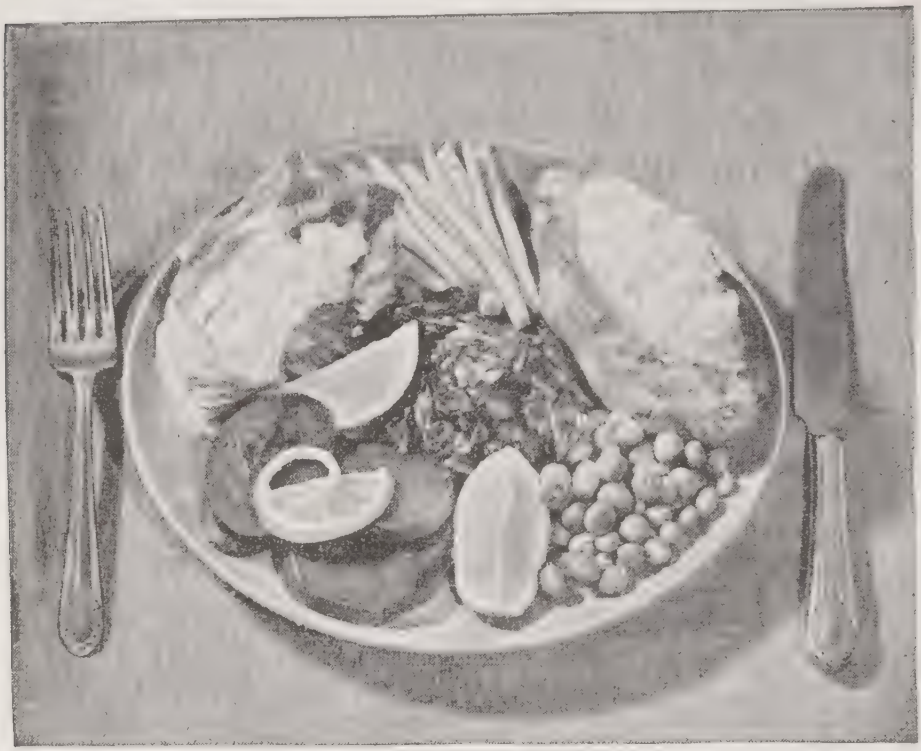
YOUR CALORIE REQUIREMENTS

Foods vary widely as to the amount of energy they can produce when burned in the body. It is impossible to gain a complete conception of nutrition without some understanding of what these values are. This knowledge will also help you to avoid either overweight or underweight.

Your needs for energy. The most obvious need for energy is to make muscular work possible. Yet, even when your body appears to be at rest, many types of activity still continue to use up energy.

The continuous beating of your heart requires energy; the work of the muscles moving the chest and diaphragm in breathing uses still more energy; even greater amounts are needed for the muscles to maintain their tension, or tone, which never lets up even when a person is completely relaxed. This tone is shown by the fact that when a patient is under an anesthetic (as during an operation), if a muscle is cut crosswise, the two end sections immediately shorten, or contract. In addition, there are many almost constant body activities which use up energy, such as the expansion and contraction of blood vessels in controlling body temperature, and the muscular movements of the stomach and intestine incidental to the digestion of food.

Sources of energy. The sources of energy are fat, carbohydrates, and proteins. If you have ever overheated fat in a frying pan, you know that it may catch fire and burn. Anyone who has been on a wiener or a marshmallow roast knows that



Generous amounts can be eaten on a reducing diet, provided the foods are carefully chosen. Cottage cheese, 50 calories; carrot sticks, 20 calories; baked potato, mashed with milk, 100 calories; spinach, 25 calories; peas, 100 calories; beets, 30 calories; lemon, 10 calories. Total number of calories, 325 calories.

both protein and sugar burn and give off heat. Since high temperatures are incompatible with life, the principal difference between food being burned outside and inside the body is that food is burned more slowly in the body.

The value of any fuel can be measured by the amount of heat it produces. The amount of heat produced when fat, sugar, or protein is burned can be measured. The measure of heat used is called a *calorie,* which is the amount of heat required to raise the temperature of 2.2 pounds of water one degree centigrade.

One fifth of a teaspoonful (one gram) of pure protein or

carbohydrate yields four calories in the body when burned. Fats are the most concentrated fuel and supply nine calories per gram.

Though the calorie is actually a measure of heat, the body does not use food as does an engine whose source of energy is heat. In the body the reverse is true. The body transforms food directly into energy which is in turn changed into heat as it carries on the internal and external work of the body. Heat in this case is merely a by-product. But, since it represents transformed energy, the measure of heat is also the measure of the energy first produced.

Foods, as they occur in nature, are usually mixtures of fat, carbohydrate, and protein. The amount of each of these three is determined chemically, and is stated in grams of each per hundred grams of food. For example, one hundred grams (almost one-half cup) of whole milk contains three grams of protein, five grams of sugar, and four grams of fat. Since there are nine calories in each gram of fat and four in each gram of both sugar and protein, the total calories in one-half cup of whole milk are:

Protein	$3 \times 4 = 12$
Sugar	$5 \times 4 = 20$
Fat	$4 \times 9 = 36$
Total calories	$= 68$

If the cream were completely removed, as in skim milk, the total calories would be thirty-two. In this manner, the calories in all foods are computed and added together to give the total calories supplied by any given amount of food. Calories contained in average servings are given in the tables on pages 442–465.

Calories versus other requirements. As long as there is no scarcity of food, the healthy individual who has no tendency

Tables for Height and Weight Without Clothing

WOMEN						MEN					
FT.	IN.	15 YR.	20 YR.	25 YR.	30 YR.	FT.	IN.	15 YR.	20 YR.	25 YR.	30 YR.
		90	95	97	100			92	101	105	109
4	8	**100**	**105**	**108**	**111**	4	11	**102**	**112**	**117**	**121**
		113	117	122	125			114	126	131	136
		91	96	99	102			94	103	107	111
4	9	**101**	**107**	**110**	**113**	5	0	**104**	**114**	**119**	**123**
		114	119	124	127			117	128	134	138
		92	98	101	104			96	105	109	113
4	10	**102**	**109**	**112**	**115**	5	1	**107**	**117**	**121**	**125**
		115	123	126	129			120	131	136	140
		94	100	103	105			99	108	112	115
4	11	**104**	**111**	**114**	**117**	5	2	**110**	**120**	**124**	**128**
		117	125	128	132			124	135	139	144
		96	103	104	107			102	111	115	118
5	0	**107**	**114**	**116**	**119**	5	3	**113**	**123**	**128**	**131**
		120	128	131	134			127	138	144	147
		99	105	107	110			105	114	119	122
5	1	**110**	**117**	**119**	**122**	5	4	**117**	**127**	**132**	**135**
		122	132	134	137			131	143	148	152
		102	108	111	113			109	118	123	125
5	2	**113**	**120**	**123**	**125**	5	5	**121**	**131**	**136**	**139**
		127	135	138	141			136	147	153	156
		104	111	113	116			113	122	126	129
5	3	**116**	**123**	**126**	**129**	5	6	**125**	**135**	**140**	**143**
		131	138	142	145			140	152	157	161
		108	113	116	119			116	125	130	132
5	4	**120**	**126**	**129**	**132**	5	7	**129**	**139**	**144**	**147**
		135	142	145	149			145	156	162	165
		112	117	120	123			120	129	133	136
5	5	**124**	**130**	**133**	**136**	5	8	**133**	**143**	**148**	**151**
		140	146	149	153			149	161	166	170
		115	121	123	126			123	132	137	141
5	6	**128**	**134**	**137**	**140**	5	9	**137**	**147**	**152**	**156**
		144	151	154	158			154	165	171	175
		119	124	127	130			128	136	141	145
5	7	**132**	**138**	**141**	**144**	5	10	**142**	**151**	**157**	**161**
		149	155	158	162			159	170	176	181
		122	127	131	133			132	141	146	150
5	8	**136**	**141**	**145**	**148**	5	11	**147**	**156**	**162**	**167**
		153	159	163	167			165	175	182	188
		126	131	134	136			137	145	151	156
5	9	**140**	**145**	**149**	**151**	6	0	**152**	**161**	**168**	**173**
		158	163	167	170			171	181	189	194
		131	134	137	140			141	150	157	161
5	10	**145**	**149**	**152**	**155**	6	1	**157**	**166**	**174**	**179**
		163	168	171	174			176	186	195	201
		135	139	140	143			146	154	161	167
5	11	**150**	**154**	**156**	**159**	6	2	**162**	**171**	**179**	**185**
		168	173	176	179			182	192	201	208

THREE WEIGHTS GIVEN

1. Middle figures *dark*, for medium build (medium bone weight for height). Average weight. 2. Upper figures for slender build (light bone weight for height). 10% reduction from average weight. 3. Lower figures for large frame (heavy bone weight for height). 12½% added to average weight. (The ideal weight for 30 years should be maintained throughout life.)

to gain or lose can usually trust his appetite to gage the needed number of calories. Persons who are underweight or overweight cannot do this.

Statistics from insurance companies indicate that men and women are healthier if they maintain throughout life the average weight for their height at thirty. Heretofore, health authorities have believed that the women under thirty are inclined to be too thin. This supposition may not stand the test of experimental research.

Dr. McCay and co-workers of Cornell University have carried out animal experiments to determine the effect of low-calorie diets. When rats were fed an adequate diet and allowed to eat as much as they chose, the average life span was 600 days. When given food generously supplied with vitamins and minerals in meals so small that the animals were kept slightly hungry, the average length of life increased to 1068 days. The underfed animals retained a healthy and youthful appearance until late in life. The Cornell scientists point out that 600 days in a rat's life corresponds to almost 60 years, and 1068 days to 107 years.

This research and many other studies would seem to indicate that an abundance of vitamins and minerals is of greater importance than the calorie intake and that, provided vitamins and minerals are amply supplied, slight underweight may be advantageous at any age. For this reason the counting of calories is no longer considered as of such primary importance as it was a few years ago.

When unrefined foods are used exclusively, the more food eaten, the more minerals and vitamins are obtained. Hence the slightly overweight child has in the past been more healthy than the underweight one. The greater health was due to the larger vitamin and mineral intake, however, and not to the excess weight.

Although very few people in America actually go hungry, the need for calories must not be underemphasized. For example, during famines a little food has usually been obtainable, and deaths were generally caused by deficiencies of vitamins and minerals. However, following the civil war in Spain, a study of a group of Spanish children revealed that the almost total absence of food caused them to die not from deficiency diseases but from lack of calories. Starvation had reached the point where all stored fat and the less important muscles had been used to produce energy. The only other source of energy was the vital organs necessary to sustain life itself.

Variation in calorie requirements. The calorie requirements vary depending on age, sex, temperature, kind of food eaten, the type and amount of exercise taken, and the proportion of non-fat weight of the body. During the first year of life an individual uses the highest number of calories per pound. The body processes are being performed at a higher rate of speed than at any other time in life. After the first year, the number of calories per pound needed for internal work falls and, at puberty, gradually rises again. During adult life, the calorie need remains rather constant, at about one calorie per hour for every 2.2 pounds (1 kilogram) of body weight and falls again with advanced age.

Women need somewhat fewer calories than men do in order to maintain the internal work of their bodies, probably because they have a larger proportion of inactive tissue, or fat.

Cold climates increase the need for calories in order to maintain an even body temperature. In the absence of exercise, heat comes from energy spent in maintaining muscle tone. If this amount of heat is insufficient, more is produced from the conversion of energy used in shivering. On the other hand, the taking of food, especially protein-rich foods, causes more calories to be burned, and for that reason large amounts of

fat-free meats should be eaten by a person wishing to reduce.

Every movement of the body means that calories must be burned to supply energy. The number of calories, or the amount of energy needed, depends on the type of muscle brought into play. For example, very slow walking, which involves the use of large muscles, causes more calories to be burned than fast knitting.

The energy spent for various activities has been measured by many scientists. These activities are shown in the following table.

TABLE I. CALORIES NEEDED PER HOUR FOR DIFFERENT ACTIVITIES

ACTIVITY	PER POUND IDEAL WEIGHT	ACTIVITY	PER POUND IDEAL WEIGHT
awake, lying still	0.50	running	3.70
bicycling	1.10	sawing wood	3.12
bookbinding	1.10	sewing by hand	0.72
carpentry	1.56	by machine	0.74
dancing	1.95	singing	0.79
dishwashing	0.93	sitting relaxed	0.65
dressing and undressing	0.77	skating	2.10
driving auto	0.88	sleeping	0.43
eating	0.65	standing at attention	0.74
exercise, light	1.10	at ease	0.69
moderate	1.88	stone working	2.60
strenuous	2.90	sweeping	1.09
very strenuous	3.90	swimming	3.25
ironing	0.93	tailoring	0.88
knitting	0.73	typing rapidly	0.91
laundering	1.05	walking downstairs	2.36
painting	1.56	slowly	1.30
peeling potatoes	0.75	moderately fast	1.95
playing a cello	0.98	very fast	4.22
a piano	0.84	upstairs	7.18
a violin	0.77	writing	0.69
ping-pong	2.50	vacuum cleaning	1.78
reading aloud	0.69		

Let us suppose that your ideal weight is 120 pounds and that your activities during one day are those shown in the

following table. During that day you would require a total of 2,642 calories. If you keep a record of the activities of any given day, you can compute your calorie needs.

ACTIVITIES OF A HIGH-SCHOOL STUDENT	TIME HOURS	CALORIES PER POUND	
		per hour	total
sleeping	8	0.43	3.44
dressing and undressing	1	0.77	0.77
eating meals	1	0.65	0.65
sitting in classes, studying in evening, reading paper, *etc.*	8	0.65	5.20
lying still, listening to radio	1	0.50	0.50
walking moderately fast, between classes, to and from school, *etc.*	1	1.95	1.95
walking upstairs	¼	7.18	1.80
walking downstairs	¼	2.36	0.59
active exercise	2	2.90	5.80
playing piano	1	0.84	0.84
washing dishes	½	0.93	0.48
Total	24		22.02

Multiplied by ideal weight, 120 pounds times 22.02 = 2642.40

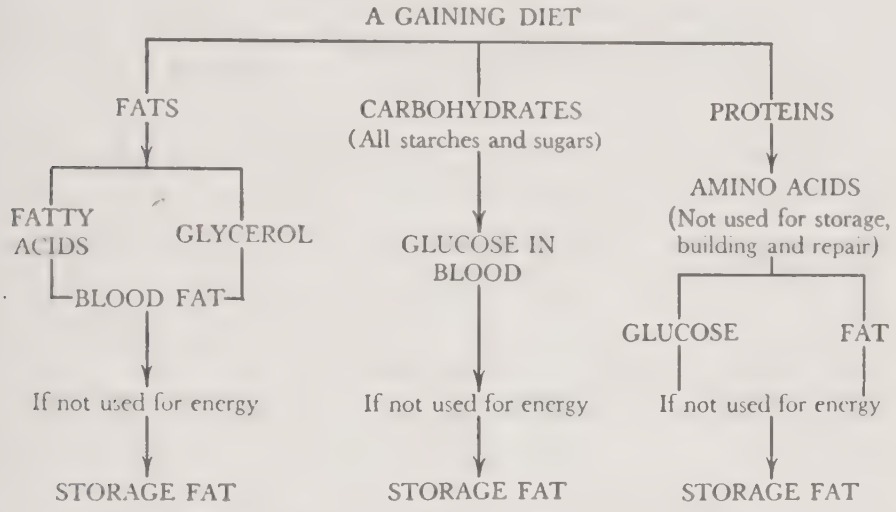
The calorie requirements of boys and girls are summarized in the following table, which allows for growth.

TABLE II. DAILY CALORIC REQUIREMENTS OF BOYS AND GIRLS IN TERMS OF AGE AND IDEAL BODY WEIGHT.

AGE (years)	CALORIES PER POUND	
	Boys	Girls
1–2	40–45	40–45
3–5	36–40	36–40
6–9	32–36	32–36
10–13	27–32	27–32
14–15	25–27	20–23
16–17	25–27	18–20
18–19	23–25	16–18

In using the above table, choose the lower figure if you are small-boned, and the higher figure if your frame is large. If

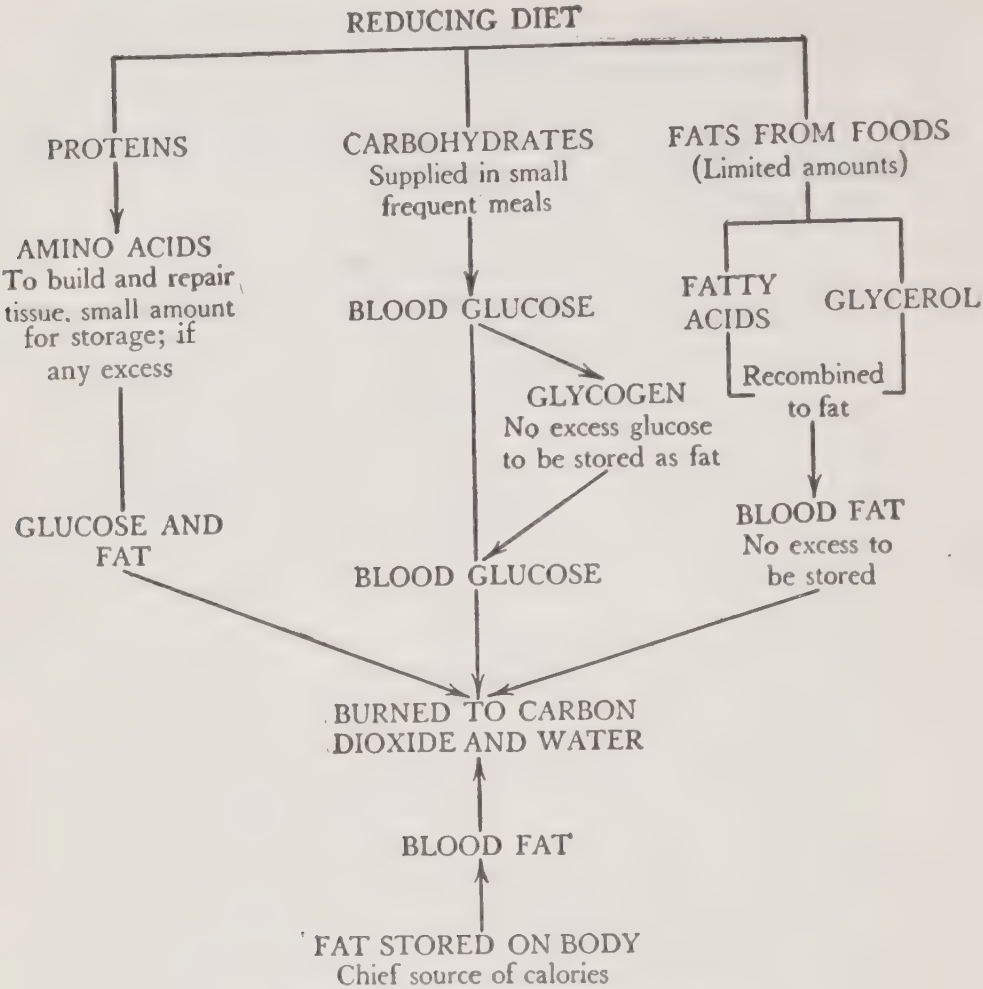
you are underweight or overweight, your energy requirements should be calculated on the basis of your ideal weight. For example, if a girl of fifteen weighs 100 pounds and should weigh 120, 23 times 120, or 2760 calories, would be her correct calorie requirement. (See Table II.)



When you eat more calories than you need.

The effect of mental work. The number of calories to sustain mental energy was carefully studied by Dr. Benedict while at Harvard University. He found that the calories supplied by half of a peanut will yield sufficient energy to support the most intensive mental activity for one hour.

It often appears that people lose weight while doing mentally difficult work. Actually such work, perhaps combined with worry, may increase the muscular tension and nervousness not only during the day but often during the night. Sleep may be disturbed. The food intake is often less. Digestion may be incomplete. In these ways, the need for energy is increased or the supply is decreased and loss of weight follows. However, the weight loss is *not* caused by extra calories used in producing energy for mental work.



When you eat fewer calories than you use.

Relation of calories to gaining and reducing. Food not needed to produce energy is stored as fat. Therefore, the person who is overweight is eating more food, that is, more calories, than his body requires. This statement remains true regardless of how little he may eat. Each 4000 calories eaten, absorbed, and not used becomes one pound of fat. (See diagram, page 77.)

On the other hand, if the person is underweight, he is obtaining too few calories. He may be eating too little food to

supply his energy needs. If he is eating sufficient food but has incomplete digestion, so little of it may be absorbed into the blood that his energy needs are not supplied. (See diagram, page 78.)

If you eat 100 calories daily which are absorbed but not used, in 40 days you will gain one pound. Since there are 4000 calories in a pound of fat, if you eat 100 calories less than you need each day, in 40 days you will lose one pound.

For anyone who wishes to gain or reduce, the first concern should be to supply the body's vitamin, mineral, and protein needs. Then the calories may be adjusted to meet the individual problem. Further discussion of this subject will be found in Chapter 8.

Unless you desire, no attempt need be made to memorize the calorie values of the average servings of food. In general, you should know which foods can supply the most calories and which the least.

Projects

1. Keep an exact record of your activities for twenty-four hours. By the use of Table I, on page 75, compute your calorie requirements for twenty-four hours.
2. From figures given in Table II, on page 76, compute your calorie requirement for twenty-four hours according to your age and ideal weight.
3. To fix clearly in your mind what occurs when one gains or loses weight, study the graphs on pages 77 and 78, then close your book and reproduce the graphs in your notebook.
4. Keep a careful record of everything you have eaten in twenty-four hours. By using the tables on pages 442–465, determine the number of calories you have eaten. In comparison with your calorie requirements, are you likely to maintain, gain, or lose weight?
5. In order to visualize the actual amount of food used to produce energy, let us suppose a person requiring 2400 calories daily met

his entire calorie need for one particular day by carbohydrate food alone. Calculate in both tablespoonfuls and cups the amount of glucose which would have to be liberated during digestion to meet this calorie requirement. If the energy came from fat alone, how much fat, stated in both tablespoonfuls and cups, would be burned? If half the energy were supplied by glucose and half by fat, how many tablespoonfuls and cups of each would be used? If, as during reducing, half the energy came from carbohydrate foods and half from body fat, how much weight would be lost? Use in calculating: 1 tablespoonful of glucose, 50 calories; 1 tablespoonful of fat, 100 calories; 1 cup, 16 tablespoonfuls; 1 pound of fat, 2 cups.

6. Let us suppose a person planned to eat a reducing diet supplying 1250 calories per day, of which 250 calories (62.5 grams) were to be furnished by protein, none by fat, and 1000 calories from 5 per cent vegetables. Approximately how many cupfuls of these vegetables would be allowed for one day? Use the tables on pages 33 and 442–465.

Topics for Discussion

1. What is muscle tone? Why would a person with good muscle tone be inclined to be less chilly than one with poor tone? Why are old people so often cold? How does shivering increase the temperature of the body?
2. When does the body use the least energy? When lying perfectly still, how does your body use energy? Why do some people need more energy than others under identical conditions? Why would a slender person use more energy than a fat one, even when both weigh the same?
3. Why is the counting of calories considered to be less important now than it was a few years ago? Does correct weight imply ideal health? Give reasons for your answer.

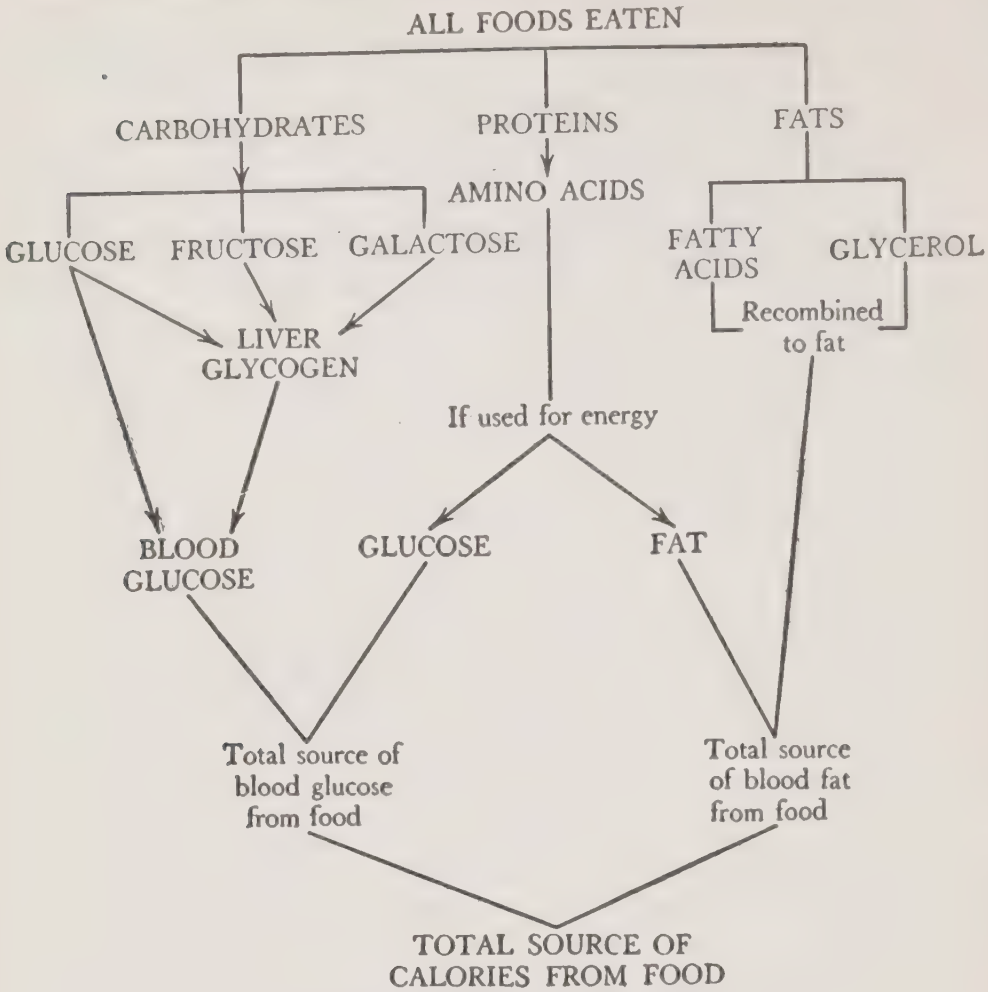
Chapter 8

HOW CALORIES ARE BURNED EFFICIENTLY

We have seen that calories are derived from each of the three classes of foods: fats, carbohydrates, and proteins. We have also seen how, of the wide variety of foods eaten, all are broken down by the digestive enzymes to form only four simple substances: fatty acids, glycerol, amino acids, and simple sugars. We have seen how fatty acids and glycerol are recombined to form fats; how fructose and galactose are changed into liver glycogen which is broken down to glucose as it is needed; how the amino acids which are not used for building, repair, or storage protein are changed either to glucose or to fat. We have therefore seen that the body can reduce fat, carbohydrate, and protein from any of the hundreds of foods which we might eat to two simple substances: *fat* and *glucose*. In the final analysis, it is in the form of either fat or glucose that all calories, regardless of their original source, are used. (See diagram, on page 82.) Either fat or glucose, therefore, as our only sources of energy, must be supplied to every cell of the body, each minute, from the very beginning of life until death. Now let us see how our bodies can most efficiently produce energy from fat and glucose.

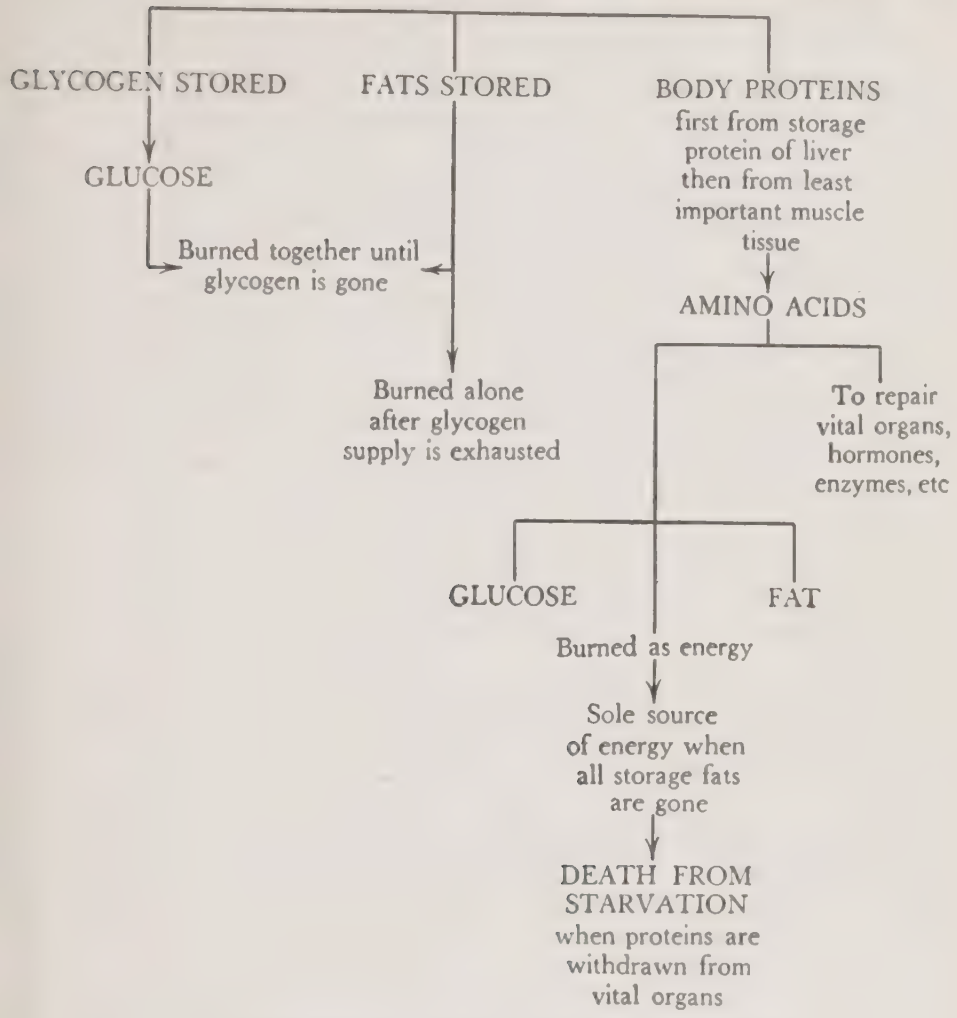
Replenishing the food supply. As glucose and fat are withdrawn from the blood and burned, the supply in the blood naturally decreases. If no food is being absorbed from the intestine, glucose is replenished from the breakdown of stored glycogen, provided there is any glycogen stored.

In case no food is being absorbed nor any glycogen has been



The sources of calories from food.

stored, the supply of blood sugar must come from stored proteins or proteins of the least-used muscles. These proteins are broken down by enzymes in the cells to amino acids, carried to the liver where their sulphur and nitrogen are removed, and changed finally into fat and glucose. In this case, the amount of glucose in the blood is less than that supplied when glycogen is stored, for the body conserves its proteins. The cells of the nerves and brain, however, derive energy only from glucose and, if the glucose supply drops too low, death results.


GLYCOGEN STORED
FATS STORED
BODY PROTEINS
first from storage protein of liver then from least important muscle tissue
GLUCOSE
Burned together until glycogen is gone
AMINO ACIDS
Burned alone after glycogen supply is exhausted
To repair vital organs, hormones, enzymes, etc
GLUCOSE
FAT
Burned as energy
Sole source of energy when all storage fats are gone
DEATH FROM STARVATION
when proteins are withdrawn from vital organs

The sources of calories when no food is eaten.

When no food is coming in from the digestive tract, blood fat is replenished by fat which has been stored either in the liver or on the body, provided any fat has been stored.

In case no food is being absorbed and no glycogen, protein, and fat are stored (which might be true of an extremely underweight person who has not eaten for some time or of anyone during starvation), the sole source of both fat and glucose is the protein from the body tissues.

The blood is therefore like an ever-moving belt carrying supplies to workers along an assembly line. As supplies are removed by the workers, so are foods removed by the cells. In the same way that new supplies might be placed upon a moving belt, so do new supplies of glucose and fat pour into the blood to replace those already used up.

If the amount of glucose in the blood is somewhat above normal (as it is after you have eaten sugar-forming foods) glucose alone is burned to produce energy. In this case energy is produced with great efficiency. The burning of glucose alone, however, does not continue long, because the excess glucose is quickly withdrawn from the blood and stored as glycogen, or, if the liver and the muscles have all the glycogen they can hold, the remaining excess glucose is changed into fat and stored as such. Under normal conditions, the person who eats a mixed diet obtains his energy from fat and glucose being burned together. In this case energy production is also efficient, and both substances are completely changed to carbon dioxide and water. If the amount of glycogen stored has been largely used up, the blood glucose falls below normal and, with the exception of cells of the nerves and brain, the body burns fat alone.

When fat is the sole source of energy, it cannot be burned completely to carbon dioxide and water as it can when glucose is available. The fat is only partly burned to carbon dioxide and water, leaving as by-products two acids and a substance known as *acetone*. Acetone, which is often used to remove nail polish and so is probably familiar to the girls, has a characteristic odor. Since the acetone from incompletely burned fat in the body is thrown off by the lungs, the person who is burning only fat for energy has the characteristic odor of acetone on his breath. Whenever you detect acetone on a person's breath, you can be sure he needs sugar-forming food.

Efficiency in relation to frequency of meals. Two physiologists, Dr. Haggard and Dr. Greenberg of Yale University, set out to study the causes of fatigue. They conducted an experiment in a factory where men and women sewed the tops of tennis shoes together. The efficiency of the workers was measured by the number of pieces finished each hour and by the frequency of their mistakes. The speed and accuracy of their work were correlated with the number of meals eaten. Scientific tests were made at hourly intervals during the day to find whether the individual workers derived their energy at any given time from fat, glucose, or the two burned together.

These doctors found that people who ate breakfast were efficient during the first part of the morning. By 11 A.M. they worked less quickly, thought less clearly, and made more frequent mistakes than earlier in the morning. Half an hour after lunch they again became efficient, but their efficiency gradually decreased throughout the afternoon.

The workers who ate no breakfast sewed fewer shoe-tops per hour, became more tired throughout the morning, did their work less well, and made more mistakes than those who had eaten breakfast. These same people, however, quickly improved after lunch.

The people who ate breakfast but missed lunch started their day well but they worked more slowly and made more frequent mistakes each hour progressively throughout the day.

The workers who ate a small amount of fruit or other sugar-containing food in the middle of the morning and again in the afternoon were more efficient than those who ate both breakfast and lunch. They worked continuously and cheerfully all day at a steady rate, made fewer mistakes, and suffered less from fatigue than any of the other groups.

Midmeals of sugar-forming foods were then given the

groups who missed either breakfast or lunch and who had been least efficient. These workers felt better, worked more quickly, and made many fewer mistakes than when they ate less frequently.

The scientists studied the amount of sugar in the blood and found that it increased sharply within a half hour after eating. If another meal was not taken, within two to four hours, depending upon the quantity of sugar-forming foods already eaten, the amount of sugar in the blood decreased to that found during fasting, or when no food is eaten. They found that the extent of the pickup from the midmeals was in direct proportion to the amount of glucose formed during digestion from the food given. For example, when milk was given alone the pickup was less than when milk was given with fruit or crackers which supplied more glucose.

When glucose was burned alone or with fat, the workers felt better, had more "pep," and were mentally more alert than when fat was the sole source of energy. Small frequent meals were much more advantageous than when the same amount of food was taken in one or two meals throughout the day. This finding was true of both men and women.

When fat is burned alone. The mental and physical fatigue which results from eating only three meals a day has probably been experienced by everyone. When you feel more tired before dinner than you do an hour or two after dinner, it is the sugar pouring into the blood from the digesting food which gives you the after-dinner pickup. Fatigue and muddled thinking are the first results to appear from fat being burned alone. When fat is burned alone over a longer period, the accumulation of acids from incompletely burned fats, together with inefficient energy production, result in extreme fatigue, irritability, nervousness, mental depression, headache, nausea, and even vomiting.

Many people who try to reduce eat little sugar-forming food at meals and none between meals; as a result their bodies burn fat alone, and they become irritable, nervous, tired, and often suffer from headaches. Children are so active that they burn the glycogen stored in their bodies quickly. The resultant decreased amount of sugar in their blood accounts for their craving of sweets, whereas the inefficient burning of fat causes them to be irritable, and often to cry easily before meals. The car-sick child is usually one who either forgets to eat or fails to digest his food because of the excitement or perhaps fatigue of the trip. The burning of fats alone to supply energy causes the nausea experienced by mountain climbers and the vomiting spoken of as mountain sickness. During many illnesses and infections people are too sick to eat, and extreme fatigue, nervousness, nausea, and even vomiting may result, caused not by the illness itself but by the incomplete burning of fat when no sugar-forming food has been eaten. The vomiting following operations is caused by too few sugar-forming foods being eaten before and after surgery, often exaggerated by large amounts of fat brought into the blood by fat-dissolving anesthetics. The inefficient production of energy due to the incomplete burning of fats is so common that you can observe it almost daily either in yourself or in those around you.

We have seen that all energy production comes from the burning of either glucose or fat. Now we find that efficient energy production depends upon only one substance,—the amount of glucose available to the cells, which, except immediately after meals, comes largely from glycogen stored in the liver and muscles.

Sex difference in glycogen storage. If enough sugar-forming foods are eaten, men can store twice as much glycogen as women can. Apparently, since men are the protectors and the fighters, they are endowed by nature with this greater supply

of ready energy. Since less glycogen is stored in a woman, the amount of sugar in her blood drops sooner than a man's unless she eats sugar-forming foods more frequently than he. A lower amount of blood glucose causes women to differ considerably from men. Women, unless they eat more frequently than men do, become tired more quickly. If the blood glucose is not replenished by frequent meals, women are somewhat less mentally alert than men. They become hungry sooner. They more often crave sweets, therefore are more likely to overeat and thus gain more easily than men do. It is more difficult for women to reduce than for men, unless the glycogen stores are replenished by small, frequent meals.

Children are so active that they quickly use up stored glycogen, and the blood sugar rapidly falls below normal. In this respect they resemble women more than men, and should always be given frequent meals. Their craving for between-meal snacks is a natural one.

Our present-day eating habits. People today, compared with generations ago, take little exercise. If they eat hearty meals generous in sugar-forming foods, so much sugar may be changed into glycogen that the muscles and liver have all they can hold. When little exercise is taken, however, most of this glycogen is not used up. If another meal is eaten, the sugar pouring into the blood cannot all be changed into glycogen because the glycogen depots are already largely full. The glucose is, therefore, changed into fat. (See diagram, page 77.)

People who do not wish to gain weight and who take little exercise have adjusted themselves by eating smaller meals and more low-calorie foods, especially vegetables, than our grandparents ate. Breakfast and lunch are often particularly light. So few sugar-forming foods are eaten that little glycogen can be stored, and, this small amount is, as the experiments of Dr. Haggard and Dr. Greenberg have shown, exhausted before

the next meal. Fat alone must, therefore, be burned for energy.

The heaviest meal of the day is usually dinner, most often served in the evening. The amount of glycogen then stored is larger than at any other time, yet, during the night, less exercise is taken and less glycogen used than at any other time. The glycogen stored is therefore likely not to be used up by morning; the amount of sugar in the blood is probably still normal. Few or no hunger contractions are stimulated, hence you have little or no appetite for breakfast. The exercise taken during the morning, however, uses up the glycogen stored from dinner, and, if a morning midmeal is not eaten, your efficiency lags.

Actually, breakfast should be the heaviest meal of the day and the evening meal should be the lightest. Farmers, who usually eat a heavy breakfast, a hearty midday dinner, and a light supper, have more nearly ideal eating habits than any other group of people. The men who work in offices and factories have no time to eat a heavy meal except at night, and their wives, often also employed, have no other time to prepare such a meal. There is little likelihood, therefore, that our present eating habits of two light meals followed by a heavy evening meal can or should be changed.

When food is plentiful, most European peoples eat more frequently than we Americans. For example, the English stop work for tea and cakes, the Scandinavians serve coffee with bread and butter between meals. In America, the three-meal-a-day habit came in with the industrial system, not because it was scientifically sound, but because only an hour was given for lunch, and eating between meals became impossible. There is little doubt but that short periods for *midmeals* will eventually be given to workers in this country, and such periods must be given if our high standard of efficiency is to be maintained.

Our problem, in short, is this: if we eat enough sugar-forming foods to store the maximum amount of glycogen so that energy can be produced efficiently, we run the risk of eating more than we need and glucose will be changed into fat. On the other hand, if we eat too little, no glucose will be stored as fat, but so little glycogen will be formed that the supply will be exhausted before the next meal; fatigue will set in, and thinking will be more muddled and nerves more tense because the cells of the brain and nerves can derive energy only from glucose. There is only one solution to the problem for the person who takes little exercise, the person who works hard but who eats a light breakfast and lunch, and for any person who misses a meal: small midmeals.

Objections to midmeals. People have been told for so many years that eating between meals is harmful that it is difficult to dislodge the old belief. When they first learn that the practice of eating midmeals is scientifically sound, they usually raise three objections.

The first objection is that the stomach needs rest. Experiments in which balloons were swallowed and connected with graphs so that all movements of the stomach could be recorded, have shown that the empty stomach contracts, or works, much more than a stomach which contains food. Therefore, contrary to popular opinion, if you want to rest the stomach, you should eat frequently.

The second objection is that eating between meals causes an undesired gain in weight. It cannot be overstressed that the entire amount of food eaten during the day need not be increased. Less should be eaten at mealtime to balance that eaten between meals, so that the total calorie intake will be the same. Actually if the person does wish to reduce, eating midmeals prevents him from being overhungry at mealtime, hence he is less likely to overeat. The first law of any good reducing

diet is to eat low-calorie foods frequently, or to eat midmeals.

The third objection is that the appetite will be destroyed and that the next meal will not be eaten. This objection is a serious one, especially in the feeding of children, and it must be considered. The midmeals should be served at definite times, such as 10 A.M. and 3 P.M. They should never be used as an excuse to eat indiscriminately throughout the day, which would, indeed, destroy the appetite for the next meal. If a person wishes to gain, the earlier he eats his midmeal, the more quickly he will become hungry again. The reverse is true for the person who desires to reduce.

The midmeals should always be small and consist largely of fresh or dried fruit, or milk and whole-grain crackers, or a small sandwich, or vegetable or fruit juices. Candy, honey, jam, jellies, and other concentrated sweets should be avoided, because they satisfy the appetite more quickly than any other known foods. Due to their concentration, they form too much glycogen and the blood sugar does not drop sufficiently to stimulate hunger contractions by the next meal. For example, a candy bar containing 500 calories would form five times as much glycogen as would an apple, an orange, or a banana.

Practical application. No subject in the entire field of nutrition can have so much influence on your personal life as a thorough understanding of how energy may be produced efficiently. Inefficient energy production causes people to suffer needlessly from fatigue, to think less clearly than they might, and to be, both mentally and physically, less capable and less serviceable than it is possible for them to be. How can you best apply this knowledge to your own life?

First, remember that all fruits, vegetables, breads, cereals, and foodstuffs made from grains supply sugar after they are digested. If you are tired, fruits give you the quickest pickup because they contain glucose and fructose, which need not be

Some midmeals may consist of fruit or fruit juices.

broken down by digestive enzymes before reaching the blood. If you are to have an examination at 11 A.M. and will not be able to eat later than at breakfast, eat bananas, cooked cereal, bread, or similar starchy food which must be broken down during digestion to sugar so that glucose will be entering your blood gradually for three hours after you have eaten. If you are to be in competitive races or to play in a football game where you will need much ready energy, eat a heavy meal of sugar-forming foods the night before so that your muscles and liver can store the maximum amount of glycogen. If you ate heartily just before vigorous exercise too much of your blood supply would be called to your digestive tract. If you wish to reduce, avoid fats, eat low-calorie sugar-forming foods at each meal, and be especially careful to have skim milk, raw carrots,

tomatoes or tomato juice, and other such foods between meals. If you get up too late or do not care to eat a large breakfast, at least have some food such as fruit, fruit juice, or cereal, which will supply glucose. If you become so ill that you do not care to eat, you must have some sugar-forming food, such as fruit juices, at frequent intervals.

In order to help the body produce energy efficiently and to prevent the burning of fat alone, every person should eat some carbohydrate food between meals. Small midmeals are especially important for children, women, all overweight people, and unusually active persons of all ages. The old idea that one must never eat between meals cannot die out fast enough.

Case Histories

1. *Alice M.* was a high-school girl who frequently became extremely weak and fatigued. On taking exercise or at the least excitement she would become shakey. She often fainted. If she chanced to go without breakfast, her symptoms became more exaggerated. Alice consulted a physician who found her average blood sugar to be unusually low. He told her to eat six small meals daily instead of the same amount of food in three meals. As soon as she did this her symptoms magically disappeared.
2. *H. G. M.,* a dentist, happened to care little for most carbohydrate foods. For breakfast he usually ate two eggs, bacon, melba toast thickly spread with butter, and coffee without sugar but with generous amounts of cream. Since there were no good restaurants near his office, he ate no lunch. His dinner generally consisted of meat, gravy, vegetables, and no more than one slice of bread. He avoided potatoes because he was slightly heavy, but nevertheless ate butter liberally on his vegetables and bread. He did not enjoy desserts. He felt well during the evening and early morning. Soon after he started to work, however, he became fatigued and the fatigue increased steadily throughout the day. By early afternoon he was nervous, could not think clearly, and would begin to hope that the three and four o'clock appointments would be canceled. He invariably had a headache by late afternoon. He

was advised to drink fruit juice at breakfast, to have a banana for lunch, and to keep dried fruits in the office to eat at frequent intervals. To his amazement he felt extremely well beginning with the very first day this schedule was followed.

Projects

1. Obtain acetone and have each person in the class smell it. If any overweight pupil has come to school without breakfast, see if acetone can be detected on his breath. What does the odor of acetone on the breath tell you?
2. Outline a breakfast for the morning of final examinations; a dinner for a member of a football team the night before a game.
3. Plan menus for breakfast, lunch, and dinner which contain the number of calories you would need for one day. Rearrange the same foods into three meals and three midmeals. In this case, would eating between meals cause you to gain weight?
4. To fix the sources of energy clearly in your mind, study the graphs on pages 82 and 83; then close your book and reproduce the graphs as accurately as you can in your notebook.

Topics for Discussion

1. Before operations, patients are often asked to eat one or two pounds of jelly beans or gumdrops. Why? Why are not chocolate creams recommended?
2. Let us suppose a group of people are adrift in a lifeboat without food. Would the men or the women be apt to suffer more during the first few days? Which would feel better, the people who are overweight or those who are extremely slender? Why? Which would die soonest from starvation?
3. If you get up late and have time to eat only a little breakfast, which foods would be better to eat: bacon, eggs, fruit, fruit juice, or cereal? Give reasons for your answers. If a person is overweight, is it all right for him to avoid breakfast?
4. If you are tired, which food would give you the quicker pickup, orange juice or mashed potato? Why? Which would give you the more sustained pickup? Why?

PART TWO

WHAT VITAMINS CAN DO FOR YOU

Chapter 9

HOW VITAMIN A CAN HELP YOU

Vitamins are chemical substances essential for health and normal development. They cannot be made in the body but must come from food. Unlike fats, carbohydrates, and proteins, they cannot serve as sources of energy.

The skeptics can no longer say, "No one has ever seen a vitamin." Just as synthetic rubber and synthetic perfumes have been made chemically, so have many of the vitamins been made, or synthesized, in laboratories. These vitamins are as easily seen as sugar.

The nature of vitamin A. Vitamin A, like sugars and fats, is made of carbon, hydrogen, and oxygen. It is a clear, colorless substance found in liver, milk, eggs, and fish-liver oils. It is formed in the liver of animals and humans from a substance known as *carotene.*

Yellow fruits and vegetables and all green plants contain carotene, so named because it was first separated from carrots. In concentrated form, carotene is a deep orange-red, but in the amounts in which it usually occurs in foods, it is a bright yellow. Carotene gives the color to apricots, yellow peaches, sweet potatoes, carrots, and yellow corn. But, green foods often contain more carotene than yellow ones.

When carotene is eaten, one molecule (particle) is changed by an enzyme, *carotenase,* in the liver into two molecules of vitamin A, the colorless substance. Because of this fact, carotene is spoken of as the *provitamin A,* which means that it precedes vitamin A. It is to vitamin A as a tadpole is to a frog.

Since studying increases the requirement for vitamin A, an evening midmeal such as whole milk and dried apricots should supply this need.

Vitamin A is formed in the animal body. Therefore, we get vitamin A proper only from animal foods such as liver and milk. On the other hand, carotene is found largely in vegetable foods. Egg yolks, butter, cream, and liver contain both caro-

tene and vitamin A proper. If a vegetable food lacks color, such as cauliflower, white turnips, and most vegetable oils, you know it also lacks vitamin A.

Since carotene is not identical with vitamin A, it is correct to say that parsley, green peppers, cantaloupe, and other green and yellow foods have only vitamin-A value. But, for all practical purposes, we group foods containing either carotene or vitamin A or both together and speak of them collectively as sources of vitamin A.

Almost enough vitamin A. When you eat almost enough vitamin A but not quite enough, you fail to see as well as you might. Vision depends upon a substance known as *visual purple,* made of protein and vitamin A. When light falls on the eye, part of the visual purple is destroyed. The products of this destruction set up nerve impulses which tell the brain what the eyes see. Next, a recovery period takes place when visual purple is again formed. The amount of vitamin A which has not been destroyed, together with an additional supply of this vitamin brought by the blood, combine again with protein to form a new supply of visual purple which is in turn destroyed by light. This cycle goes on continuously.

Vitamin A is like the film in a camera. It photographs what you see, but, in the photographing, it is used up. If you wish to take more pictures, you must have more film. Similarly, if you wish to see immediately after vitamin A is destroyed, more vitamin A must be supplied.

There are two types of vision, *day vision,* which most animals possess, and *night vision,* which the owl and the cat possess. People have both types. Vision which involves vitamin A is used during the day, although the vitamin-A mechanism is not depended upon entirely. Light, however, continuously destroys the vitamin. On the other hand, night vision depends entirely upon the vitamin-A mechanism. For this reason, if

you have a lack of vitamin A, even before your day vision is impaired, you will have difficulty in seeing in dim light or in the dark. This condition is called *night blindness*, or, in a mild form, *partial night blindness*. It is so extremely common that everyone has probably suffered from night blindness at some time or another, although he may have been unaware that anything was wrong. Usually the person assumes that others experience the same visual difficulties as he does.

A test for vitamin A. Scientists have worked out an eye test which indicates to a certain extent the amount of vitamin A in a person's body. But, in order to give correct results, this test must be administered by a physician or a qualified technician. The person to be tested is either put in a dark room or else carefully blindfolded so that no light reaches his eyes (usually for ten minutes). Since he sees nothing, the vitamin A in his eyes is not destroyed. Then he looks into an instrument called a *photometer*. Here a bright light is thrown into his eyes for a given time. This light destroys all the vitamin A which has accumulated in his eyes during the period of darkness. Then the field of vision is made dark again, and only a tiny light is shown. The dim light is usually in the form of a small arrow which can be turned. As soon as the person being tested can see, he states the direction the arrow points, proving that he has seen it.

If the person has eaten sufficient vitamin A to allow the blood to be rich in this substance, he can see the small light almost immediately. If he partially lacks vitamin A, and the blood contains little, it may take him some time before sufficient amounts of that meager supply accumulate in his eyes so that he can see the lighted indicator. One person may be able to see three minutes after his visual purple has been destroyed; another, not until twenty minutes afterward. Since vision depends on vitamin A, the length of time before the small light

can be seen in the darkness indicates the amount of vitamin A in the body. A person severely deficient in vitamin A is completely blind when in the dark.

Value of the vitamin-A test. This test is only used to give a general indication of the amount of vitamin A in the body because there are other causes of night blindness. It has been, however, of much value to scientists and physicians in studying vitamin A. For example, an experiment was carried out at Loyola University to determine how quickly a lack of vitamin A could affect the eyes. Ten students were tested by the photometer. All were able to see the dim light in from one to three minutes, which is considered a normal time. For the duration of the experiment, they ate only white cereals, breads, sugar, skim milk, and vegetables lacking carotene, such as turnips, white potatoes, kraut, beets, and cauliflower. The entire diet supplied very little vitamin A. The students' eyes were tested each week day. Within ten days after the beginning of the inadequate diet, the vision of several became abnormal. The longer they stayed on the diet, the worse their vision became. For example, after one particular student had stayed on the vitamin-A-poor diet for three weeks, it took twenty-five minutes for him to see the dim light, contrasted to two minutes when his diet had been good. At the end of a month's time, the students ate sufficient foods containing vitamin A to make their vision normal again.

Hundreds of experiments similar to this one have been carried out. By this means, much has been learned about vitamin A and the extent to which deficiencies of this vitamin exist.

Vitamin A and night vision. The manager of any moving-picture theater will tell you that a surprising number of people hurt themselves in trying to find seats in the dark. The scientist will tell you why. A person enters the theater from a lighted street, where much of the vitamin A in his eyes has

been destroyed. When he goes into the dark, his night vision must be wholly relied upon. How quickly he can see depends upon the supply of vitamin A in his body.

The same changes occur when one drives an automobile at night. The lights from on-coming cars destroy vitamin A in the eyes. The person whose diet is rich in this vitamin can see again almost immediately. He who is inadequately supplied with vitamin A is blinded, the length of time depending on the severity of his deficiency.

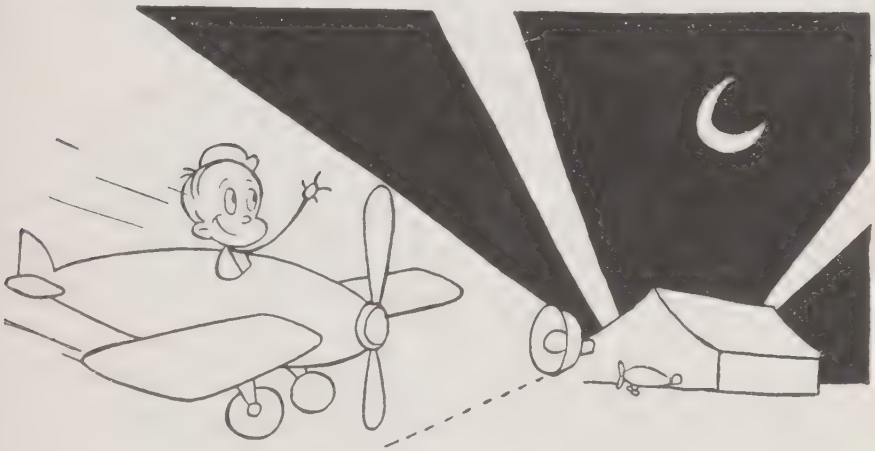
Drivers who smash their cars at night
Are often those who don't eat right.

There are many degrees of night blindness. If he has only a mild deficiency of vitamin A, the person believes that his vision is normal, but actually he drives more efficiently during the day than at night. With a slightly greater deficiency, he suffers eye fatigue, is unable to see road signs or pedestrians clearly, but he still is likely to assume that others experience similar difficulty in night driving. If his need for vitamin A is still greater, he may suffer from nervousness, headaches, and exhaustion as well as painful eyes, on long night drives. A still more severe deficiency causes many people to avoid night driving because of eyestrain and a knowledge that they cannot see clearly.

Throughout the country, people who have had accidents while driving at night have been tested with the photometer.

In almost 100 per cent of the cases the tests have shown the vitamin-A supply to be extremely low. Yet, when a driver's license is applied for, only day vision is tested. The person whose night vision may be so abnormal as to make him dangerous on the highways is still allowed to drive at will.

Dr. Jeghers of the Harvard University Medical School says, "Several hours of night driving could easily decrease the skill of a vitamin-A-deficient person to the point where his chances



If a flyer you would be,
Vitamin A will help you see.

of accident would be greatly increased." [1] Many outstanding scientists consider the lack of vitamin A as one of the major causes of automobile, train, and airplane accidents at night.

During the blackouts in World War II, many major accidents were caused by night blindness. Hence, aviators and drivers of ambulances and fire engines were asked to take cod-liver oil daily. Carrots were especially recommended to people in the darkened cities.

Most of the large air lines in this country now frequently test the eyes of their aviators with the photometer. If the men

[1] *Ann. Int. Med.*, 10, 1304, 1937.

are found to lack vitamin A, they are not allowed to fly a plane until the deficiency is overcome. This wise precaution has undoubtedly prevented many accidents, especially in forced night landings.

You may have noticed, while playing ball at dusk, that someone who is a skilled player in the daytime is a markedly poorer player in dim light. Perhaps you have heard your mother complain that she cannot see well to sew, mend, or knit at night unless the light is unusually bright. In this case, she lacks sufficient vitamin A for efficient night vision, though her day vision may still be unaffected.

When you learn to recognize vitamin-A deficiencies, you will see people all about you whose vision is inefficient because of unwisely chosen foods. The health of such people could be quickly improved by the simple addition of more carrots, parsley, apricots, and other green or yellow foods to their daily menus.

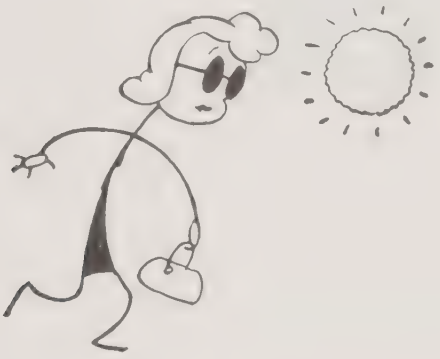
Vitamin A and day vision. The person who is slightly night blind eventually becomes sensitive to bright lights during the day and discovers that he feels better in bright light if he wears dark glasses. It is probably correct to say that most persons who wear dark glasses for comfort eat too little vitamin A to allow normal vision.

The brighter the light which shines into the eyes, the more quickly vitamin A is destroyed. Therefore, to insure good vision, people who work in intense light must eat more vitamin A than others. If they fail to plan their health to meet their individual needs, they will soon experience difficulty.

Movie actors and actresses who must work in extremely bright light often suffer from severe eye fatigue and a burning and itching of the lids. They are sensitive to light and quite frequently are obliged to wear dark glasses.

Many typists, bookkeepers, and others who must work where

bright light shines on white paper likewise suffer from eye strain, which could be prevented by diets richer in vitamin A. The photographer's model who lacks vitamin A soon squints so much under the glare of bright lights that she is no longer a successful model. The photographer himself who works both in bright light and in the darkroom often finds his tasks difficult, not knowing that the cause may lie in a diet too low in vitamin A.

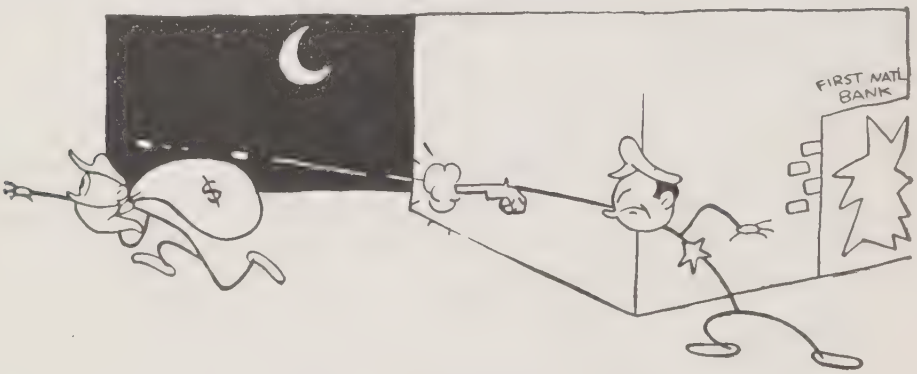


To vitamin A she gave no care
And now she cannot take the glare.

People who live or work on the desert or beach where sunlight is reflected by white sand frequently suffer from eye trouble caused by too little vitamin A. Perhaps no glare of light is so destructive to vitamin A in the eyes as sunlight on clean snow, and the trapper, hunter, and the skier are familiar with snow blindness. The boy or girl who walks to school through snow or is active in snow sports frequently feels eye fatigue, especially on days when sunshine glistens on the winter landscape.

Night blindness and sensitiveness to light are only the earliest stages of a vitamin-A deficiency. It is particularly important for you to recognize these mild deficiencies, for if the diet is improved, more serious conditions may be avoided.

Vitamin A in industry. Gradually, science is stepping in to make working conditions in industry less harmful. Such was the case in a factory in Ohio where porcelain stoves and refrigerators were assembled. The porcelain was of every shade to please a housewife's fancy: pure white, cream, ivory, and blue-white. The men had great difficulty in matching the



This guard was deficient in vitamin A.
He let the bank burglar scamper away.

shades exactly, and often a pure white door would be put on an ivory refrigerator and, unnoticed, be shipped to a customer perhaps miles away. Here the mistake would be discovered and the refrigerator returned for correction at the company's expense.

The workers complained of eyestrain, burning and itching of the lids, nervousness, and general fatigue. The artificial lights were "improved" until they were fifty times the intensity of the average lighting in a schoolroom but the mistakes became more frequent, the men more tired.

Then the workers were tested with a photometer and found to be extremely deficient in vitamin A. They were asked to eat foods rich in vitamin A, and, in addition, a concentrate of vitamin A was given the men daily. In a remarkably short time, repeated tests with the photometer showed that their vision was

normal. The workers reported that their nervousness, fatigue, and feeling of eyestrain left them and that they felt better than they had since they began working in the factory. The decrease in mistakes saved the company so much expense that each man was given, together with his pay check, a month's supply of vitamin-A concentrate.

A study was made of a group of welders who suffered similar symptoms. Again great improvement followed the increasing of vitamin A in their diets. Many industrial and commercial firms might well profit by such experience. Efficiency may be increased and much eyestrain and general fatigue avoided if people choose their foods wisely, day after day.

The effect of vitamin A on skin and hair. Though the eyes are first affected in a mild vitamin-A deficiency, if the diet is not improved, the skin soon becomes involved. The first noticeable change is dryness; the oil glands are no longer healthy. The skin is often sensitive to scratchy garments. Under the microscope the sweat pores are seen to be plugged with dead cells. As the deficiency becomes more severe, these pores become noticeable whiteheads, blackheads, or, if infected, pimples. The skin on the legs, thighs, back, shoulders, and the outer part of the upper arm is especially rough. This condition usually occurs between the ages of fourteen and twenty-five, and is so common that it can be found in almost any schoolroom.

The hair also becomes noticeably dry and lacks sheen and luster. Dandruff may accumulate on the scalp. In severe deficiencies, the hair gradually becomes more coarse and may even fall. The nails may also be affected and break easily or peel.

The lack of vitamin A among Americans. Two doctors from the School of Medicine in the University of Iowa tested more than four hundred school children with the photometer.

In one community, these doctors found that 26 per cent of the country children were eating too little vitamin A to allow normal vision. More than twice as many of the village children (53 per cent) lacked adequate amounts of this vitamin. The country children were getting more cream, butter, eggs, and perhaps more fruits and vegetables than those living in the small towns.

In another study, the children of a community were divided into groups depending on the amount of money their parents were able to spend on food. More than one half of the children from well-to-do parents (56 per cent) had abnormal vision because of insufficient vitamin A. Of the children whose parents had average incomes, 63 per cent had mild night blindness. Over three fourths (79 per cent) of the low-income group were found to have abnormal vision because of low vitamin A. Many of these people were on relief. These figures are especially startling in view of the fact that the studies were made in Iowa, the very center of the food-producing belt.

Studies like those made in Iowa have been made throughout the United States. All show similar results: that at least a third, and in many places far more than half of our population lack sufficient vitamin A to insure normal vision.

Vitamin A and income. The findings of the Iowa studies show that the more a person has to spend on food, the less likely he is to lack vitamin A. At the same time, they also reveal that sufficient money by no means insures an adequate amount of vitamin A in the diet.

A study of the diets of people living on limited incomes in New York City showed that, with the same amount of money to spend on food, some families were buying from three to five times more vitamin A than others. With education and care in the choice of food, it is possible to obtain ample vitamin A even when the income is extremely limited.

Case Histories

1. *Leonard W.* was a well-developed boy of seventeen with red hair, freckles, and an engaging grin. He went to high school in the daytime and ushered in the movies at night. Despite the fact that he had always studied a great deal, his eyes had not bothered him until after he had ushered for several weeks. He suffered from eye fatigue, his eyes became sensitive to bright lights, and he had difficulty in seeing the seats in the darkened theater. Dark glasses helped temporarily, but after a little his eyelids would begin to burn and the eyeballs ache. It soon became difficult to drive home from the theater; the lights from on-coming cars blinded him, and pedestrians and road signs were not clearly visible. In order to save his eyes he studied less, and his grades took a downward dive.

   As winter advanced, Leonard's diet suffered from the lack of fresh vegetables and fruits on the market. Then, one day in his science class vitamin A was discussed. Leonard felt that the discussion pointed directly at him. Consequently, he began eating as many foods rich in vitamin A as possible. He also bought vitamin-A capsules and took one daily. In a surprisingly short time his eyes showed improvement, and in a few weeks all of his difficulties had disappeared.
2. *George H.* is the type of boy who always wants to be the best in everything, and he usually is. Since his eyes were sensitive to light, and on bright sunny days he could not see clearly enough to hit the bull's eye, target practice, part of his ROTC training at high school, was his bugbear. He chanced to read in a magazine that vitamin A was especially helpful for the eyes. He found out that raw carrots were rich in vitamin A so he began taking several of them to school with him and has even influenced all his friends to eat carrots. His eyes are no longer sensitive to light, and he now hits the target somewhat more often than the other boys.

Projects

1. Notice the eyes of those around you and of people you pass on the street. Can you see that the eyes of some sparkle more than those of others?

2. Stand in a doorway at school some day when the sun is particularly bright. Can you notice any difference in the way people's eyes react to the sunshine?
3. Make a list of everything you have eaten during the last twenty-four hours. Using the tables on pages 442–465, figure out the units of vitamin A. Compare the total with the amount you should eat in twenty-four hours, given in page 130.
4. Go to the school cafeteria and observe lunches chosen by various students. Compute the vitamin-A units in the lunch which appears to be the lowest and the one highest in vitamin-A content. Compare the prices of the two. Could the lunch have contained more vitamin A for the same price?
5. List industries or professions in which workers need larger-than-normal amounts of vitamin A to insure good vision. Consider the people who must work in dim light or darkness or especially bright light, or who must use their eyes continuously.
6. Do you know a truck driver or an aviator who must drive or fly at night? If you do, ask him what foods he has eaten in twenty-four hours and analyze them for units of vitamin A. Compare the amount with his ideal requirement. Would you feel safe meeting the driver at night or lending the aviator an expensive plane for night flying?
7. If anyone in the class knows a typist, bookkeeper, or seamstress who complains of eye fatigue, he may ask her what she has eaten in twenty-four hours and compare that amount with her ideal vitamin-A intake. Do you think her eyestrain could come from insufficient vitamin A?
8. Make lists of foods rich in vitamin A which should be used on a reducing diet; those valuable on a gaining diet. Use the tables on pages 442–465, and observe both calorie and vitamin-A contents.
9. Make lists of the main sources of vitamin A. Divide them into foods which supply (1) only carotene; (2) vitamin A proper; (3) probably both carotene and vitamin A.

Topics for Discussion

1. What is meant by a provitamin? Could starch be called a prosugar?

2. What is the relation between vitamin A and vision? Why can some people see more quickly than others, after being blinded with bright lights? Why is a person blinded momentarily by a bright light? If life could be maintained without vitamin A, what would be the effect on the eyes?
3. Why is night vision more affected than day vision by lack of vitamin A? Why is abnormal day vision more quickly noticed than poor night vision?

Chapter 10

VITAMIN A AND NATURAL RESISTANCE

Why does one person remain well under the same conditions of fatigue, exposure, and perhaps lack of sleep which cause another to be ill? We say that the resistance of the first is high. What causes high resistance? How may it be attained?

One of the body's ways of building natural resistance depends upon an abundant supply of vitamin A. Let us see how this natural resistance is maintained.

The history of vitamin A. Those diseases of the eyes which are now known to be due to insufficient vitamin A have been recognized for centuries. The earliest reference to the use of a food rich in vitamin A in the treatment of eye disease was written about 1600 B.C. It is found in an Egyptian medical treatise in the Leipzig Museum. The translation reads, "A treatment for the eyes: liver of ox roasted and pressed, give for it; very excellent." The famous Greek physician, Hippocrates, who was born 460 B.C., advised giving ox liver in honey as a remedy for eye disease.

The early medical literature of many countries mentions conditions we now know to be due to a vitamin-A deficiency. Many references are made to sore eyes, films over the eyes, and dimness of vision, occurring especially in the late winter. Herbs are suggested as a remedy, and one, similar to parsley produced such excellent results that it was given the name, *eyebright.*

Xerophthalmia, a severe infection of the eyes caused by prolonged lack of vitamin A, has been known in the Orient for

centuries. In this disease, the lids of the eyes become swollen, sore, perhaps ulcerated, and the surface of the eye is curiously dry. If vitamin A is not given, blindness results.

During World War I a serious outbreak of this eye disease occurred in Denmark. The warring countries were paying high prices for butter, hence many of the poorer Danes sold their milk products and fed their babies skim milk and margarine. Many children became blind. The vision of other children was saved by giving them butter and cod-liver oil.

Xerophthalmia is common today among the poorer people of Egypt, India, and China, whose diet is largely cereals. It rarely occurs in America. For this reason we are much more interested in mild vitamin-A deficiencies.

Knowledge gained from animal experiments. White rats are most often used in studies of vitamin-A deficiency. It is now generally accepted that changes which take place in their bodies when the diet lacks vitamin A are also very likely to occur in humans under the same conditions.

Animals whose diets are adequate in all respects except for sufficient vitamin A are especially susceptible to infections. They develop infections in the nose, throat, bronchial tubes, sinuses, mastoids, ears, kidneys, and bladder. A sudden change in temperature often causes the death of many vitamin-A-deficient animals from pneumonia. Almost 90 per cent of the animals will develop stones in the urinary bladder, the kidneys, or the gall bladder. Infections in the digestive tracts and reproductive organs are not unusual. No one animal will suffer from all of these infections at once. Perhaps each will have only one or two infections, but when thousands of animals are studied, these same infections appear again and again. Contrasted with these animals are those given adequate vitamin A. Although their diets are identical with the first group in other respects, these animals remain free from infections.

A striking resemblance is seen when the infections produced in vitamin-A-deficient animals are compared with those suffered by children with xerophthalmia.

These two rats have been fed identically except that the animal on the left has received no vitamin A since the beginning of the experiment. Notice that it is blind whereas the normal animal has bright eyes.

PERCENTAGE OF INFECTIONS OCCURRING WHEN VITAMIN A IS DEFICIENT

INFECTIONS	EXPERIMENTAL ANIMALS	CHILDREN WITH XEROPHTHALMIA
Eye infections	88	100
Bladder and kidney infections	44	27 *
Lung infections	9	27 **
Skin abscesses	90	14 ***
Mastoid infections	20	13
Sinus infections	20	

* kidney infection only
** 15 per cent pneumonia, 12 per cent bronchitis
*** only boils and carbuncles reported

This comparison shows clearly that the same infections occur in both human beings and experimental animals when vitamin A is inadequately supplied.

Relation of bacteria to vitamin-A deficiencies. An almost complete lack of any one vitamin results in what is spoken of as a *deficiency disease*. Xerophthalmia is the vitamin-A-deficiency disease, and yet xerophthalmia is caused by specific bacteria just as pneumonia is caused by *pneumococcus*. No medication has ever been found which will cure this eye disease by destroying the bacteria involved. The addition of vitamin A to the diet causes the disease to disappear quickly if secondary infection has not caused irreparable damage.

Similarly, other infections which occur when vitamin A is not eaten in sufficient amounts are also caused by bacteria. Just as the vitamin-A-deficient tissues of the eye change in such a way as to allow bacteria to thrive on them, so do other tissues change and become susceptible to infections. In the same manner that the eyes become healthy again when vitamin A is generously added to the diet, so do other tissues become resistant to infections.

Studies have shown that even when animals are adequately fed, a small number of bacteria are always present in the nose, throat, lungs, ears and other points. When vitamin A is inadequate or lacking, great numbers of bacteria exist at the same sites. The number is roughly proportional to the degree of the vitamin-A deficiency.

The body's first line of defense. The infections resulting from a vitamin-A deficiency occur in either the outside covering or the inside lining of the body. All of the body cavities are lined, much as a coat might be lined, with a tissue spoken of as *mucous membrane*. An example is the soft pink tissue inside the mouth. Similar tissue covers the inside of the ears, the sinuses, the digestive tract, the bronchial tubes, the tiny air passages in the lungs, the gall bladder, the urinary bladder, the canals in the kidneys, and those leading from them to the bladder and from the bladder to the outside of the body.

When the diet has been adequate in all other respects, and also rich in vitamin A, the mucous membranes consist only of healthy, living cells. Individual cells which have run their life span die, and are then immediately torn down by enzymes, and the resultant wastes removed by the blood. Therefore, a healthy tissue contains few or no dead cells.

Normal cells of the mucous membrane continuously secrete a moisture, or thin *mucus*. This mucus bathes the surfaces of the tissue and washes away most of the bacteria which reach it. An example would be the small amount of moisture or mucus in a healthy nose.

When bacteria are grown in the laboratory, they must be kept moist, warm, and supplied with proper food. The body is always warm and moist. Dead cells can serve as food for bacteria. But, when the diet is adequate, there are few dead cells. Although millions of bacteria may find their way into your nose, throat, or lungs, they are largely washed away or destroyed by the mucus. There is not sufficient food to allow them to multiply enough to cause an infection. We say your resistance is high. For this reason healthy mucous membranes are spoken of as the *body's first line of defense*.

Changes when vitamin A is not adequate. Although many scientists have studied the changes in human beings and animals during vitamin-A deficiencies, perhaps the foremost authority on the subject is Dr. Wolbach of the Harvard School of Medicine. He points out that when vitamin A is inadequately supplied, cells of the mucous membranes multiply much faster than normally. These rapidly growing cells soon die and become hard and dry. The dead cells are crowded forward by still more of the rapidly growing but abnormal cells which, in turn, also die. There soon exist many layers of dead cells, something like dandruff. The moisture secreted by healthy tissue cannot be produced by these dead cells. The surface of

the tissue therefore becomes dry and can no longer be washed clean. It is also sufficiently rough to catch and hold bacteria to its surface.

In this way the bacteria are held to a generous and continuously growing food supply. They are kept warm and moist. So it is that low resistance to infections, caused by eating too little vitamin A, is in reality due to supplying food to bacteria under conditions ideal for their growth.

In still another way, an abundance of vitamin A helps to protect the body. Bacteria harm the tissues by producing enzymes which break down cells. The products of this enzyme action are called *toxins*. Toxins are foreign materials which act as poisons. On the other hand, healthy cells produce *antienzymes* to counteract *bacterial enzymes*. Thus the production of harmful toxins is prevented. The dying, vitamin-A-starved cells cannot produce antienzymes.

Recovery from vitamin-A deficiency. When vitamin A is again added to the diet, the tissues lining the body cavities gradually become healthy. Changes in the mucous membranes of animals have been observed as quickly as five days after vitamin A had been increased. In humans, the speed of recovery depends upon the amount of vitamin given and the severity of the deficiency. Recovery appears to vary from a few weeks to several months, as the dying cells of the mucous membranes are gradually replaced by healthy, self-cleansing cells.

Value of vitamin A in disease prevention. A few years ago, an experiment was carried out with men who worked in a mine. The mine was particularly cold and damp, and each winter many of the men suffered from pneumonia. A hundred men were each given a tablespoonful daily of cod-liver oil, and a similar group of a hundred workers received no additional vitamin A. During the winter, thirteen of the group

without cod-liver oil suffered from pneumonia, and four died from the disease. Of the group taking cod-liver oil, only three had pneumonia in a light form and no deaths occurred.

Interesting experiments have been conducted by Dr. Sherman of Columbia University. He has fed two large groups of rats identically except that the diet of one group was slightly low in vitamin A, the other slightly high. The group receiving more vitamin A developed normally, remained free from infections, reared healthy young, and lived twice as long as the group given less vitamin A. The low-A group received enough of the vitamin to produce almost normal growth and to allow them the appearances of good health. However, they showed increased infection early in life and particularly a tendency to break down with a lung disease similar to tuberculosis. The susceptibility to lung infections occurred at a time which would correspond to an age of fifteen to thirty years, the period when tuberculosis most frequently develops in people. These studies would indicate that a slight but long-continued deficiency of vitamin A during the growth period causes susceptibility to disease later.

There are many findings which indicate that persons with tuberculosis have eaten far too little vitamin A. In a study of 197 tubercular patients tested with a photometer, 76 per cent were quite deficient in vitamin A. More than 50 per cent were extremely deficient. The remaining 24 per cent had been given cod-liver oil as part of their treatment. The blood of tubercular patients has repeatedly been found to be low in both vitamin A and carotene. The analysis of tissues of people dying of tuberculosis has shown no vitamin A in the lungs and little or none in the liver, although both organs normally contain the vitamin.

Infections of the mastoids, sinuses, ears, skin, kidneys, eyes, and bladder are now being treated successfully with diets ex-

tremely high in vitamin A. The current infection may be little altered by the improved diet, yet resistance is built up so that reinfection is less likely. Research indicates that such infections may be largely prevented by an adequate diet consistently liberal in this vitamin.

Other infections. Infections which result when vitamin A is undersupplied are not contagious. Whether or not generous amounts of vitamin A offer protection against such contagious diseases as measles, scarlet fever, influenza, mumps, and others is not known. This vitamin is used up very rapidly during any infection and people suffering from contagious diseases have been helped by increased vitamin A. For example, during measles the eyes are protected by high vitamin A.

Vitamin A undoubtedly plays a role in many infections other than those produced by vitamin-A-deficient diets. At the University of Rochester Medical School four groups of white rats were kept on diets lacking vitamin A for four, six, eight, and ten weeks. They were then inoculated with disease-producing bacteria. The number of deaths was in proportion to the length of time the animals had lived on the vitamin-A-deficient diets.

Dr. Tisdall at the University of Toronto conducted similar experiments. Rats given generous amounts of vitamin A and others lacking it were fed bacteria which cause rat typhoid. Only 20 per cent of the well-fed group died compared to 76 per cent of the vitamin-A-deficient group.

Numerous other experiments have shown that a vitamin-A deficiency, coexistent with bacterial attack, causes animals to succumb more rapidly than others fed abundant vitamin A.

Vitamin A and colds. A great many experiments have been conducted to determine the influence of vitamin A on colds. Children in orphanages and private schools and students on college campuses have largely been used as subjects. Usually

they are divided into two groups. One group has generally been given fish-liver oil or carotene daily. The other has received only the vitamin A in ordinary foods. The number, severity, and duration of colds in both groups have been carefully recorded.

These and similar studies of the causes of colds stress that the most important factor is contagion. If you wish to remain free from colds, avoid people who have them. The second most important reason for susceptibility to colds appears to be lack of sleep. The third is apparently inadequate diet.

The lack of A spoiled her career,
Her colds are frequent and severe.

The addition of vitamin A alone will not prevent colds. Yet, the person who has severe colds, one quickly following another and hanging on week after week, is invariably benefited when generous amounts of vitamin A are added to his diet.

The limitations of vitamin A. The lack of vitamin A is by no means the only cause of susceptibility to infections. When vitamin A is more than adequate in the diet, the addition of still larger amounts cannot build up a super-resistance. Where the division point comes between adequacy and greater-than-

adequacy is not known. In all likelihood it differs with each individual.

When it was first learned that infections could readily be produced in animals by the simple withdrawal of this vitamin from the diet, it was given the name of *anti-infective vitamin A*. This vitamin was added to cough drops and similar products. Advertisements often have advised people that some vitamin-A preparation should be taken to prevent colds and other infections. People were misled into believing that if they took cod-liver-oil capsules, for example, they would be immune to colds. With such an attitude, they needlessly exposed themselves to infection. Frequently they became ill. In the end they usually decided that vitamins were useless.

In the meantime, further research revealed that an undersupply of protein or of almost any vitamin or mineral led to low resistance, and the name of anti-infective vitamin A was quickly dropped. Unfortunately, the overemphasis on the part of both laymen and advertisers had thrown into disfavor the entire relation of vitamin-A deficiency to infections. Because of this overemphasis many physicians and scientists are inclined to minimize the influence of vitamin-A deficiency upon infections, in spite of the tremendous amount of evidence to the contrary.

The role which vitamin A plays in maintaining health is undeniably an important one; it should neither be exaggerated nor minimized. Both its value and its limitations must be recognized and kept clearly in mind.

Our reason for studying causes of infection. We must never lose sight of the fact that we are studying causes of infections not so much to know how to correct the infections as to understand how to prevent them. The time is past when the intelligent person leaves his health to chance by not considering precautionary measures.

For the sake of the beauty of your hair, skin, and eyes, for the vitality and endurance which come with good health, and the freedom from eye fatigue and infections, see that your diet contains ample vitamin A daily. Then continue to obtain that generous supply throughout the coming years.

Case Histories

1. *Henry A.,* a senior in high school, came with his mother to consult a physician about his diet. For two years he had suffered almost continually from boils. He had four large ones at the time he first saw the physician. His chest, back, and arms were literally covered with scars where boils had been. Aside from the pain he had endured, he was sensitive about the scars on his face and the back of his neck.

   His diet was made adequate in all respects and especially liberal in vitamin A. He was asked to choose fruits and vegetables for their yellow and green color, and to eat parsley, raw carrots, and dried apricots daily, and liver twice each week. In addition to ordinary foods, one capsule of vitamin A was to be taken after each meal.

   Henry was a good patient and co-operated well. Perhaps a week after he began the nutrition program, a small boil appeared in his armpit, but it was the last one. He has continued choosing foods rich in vitamin A and is an enthusiastic convert for life.
2. *Caroline S.* was a vigorous, curly-haired girl who had almost never been ill. Once, when having a drippy cold, she refused to stay home from school. It did not occur to her that she was selfishly thoughtless. Harry sat next to Caroline in study hall. He was a tall, narrow-chested youngster with low resistance. Two days later Harry developed a severe cold which changed into pneumonia, and he was rushed to the hospital. For several days he hovered between life and death. Besides his suffering, there were many expenses which his family could ill afford, and endless hours of worrying and fear on the part of his parents. All of this trouble could have been avoided if Caroline had been less selfish and thoughtless.

   Caroline's attitude is far from unusual. The person who feels well enough to go about with a cold in the first and most con-

tagious stage should be made to realize the harm that may be inflicted upon others.

Projects

1. Plan menus for one day for yourself, using quantities which you could eat, and making them as high in vitamin A as possible. Check the vitamin-A units they contain.
2. Write a short sketch of someone you believe to be deficient in vitamin A, listing all the reasons for your belief.
3. Use as an example a person who has very little money to spend on food. Consider what has been eaten by that person during a twenty-four-hour period. Suggest ways for him to get additional vitamin A without spending more money.
4. Make a list of all the conditions that you observe during the week which might be related to a vitamin-A deficiency. Give possible reasons for the deficiency of vitamin A. Is it due to a lack of knowledge in choosing foods, lack of money, poor food habits, or greater-than-average requirement of vitamin A?
5. Compute the vitamin-A intake for twenty-four hours of some person you feel sure lacks this vitamin. Compare intake with ideal requirement.

Topics for Discussion

1. What parts of the body are susceptible to infection when vitamin A is inadequate? What is the relation of bacteria to infections resulting from low vitamin A? If, for example, a muscle were infected, would you suspect a lack of this vitamin?
2. How does adequate vitamin A help to protect the body from infections? What changes take place when too little vitamin A is obtained? In what diseases or infections would you suspect low vitamin A to be a causative factor? Should vitamin A be increased in the diet of people suffering from such infections? Would an increase in vitamin A bring about an immediate improvement in the infection? Give reasons for your answer.
3. Can abundant vitamin A prevent colds? Why was the name *anti-infective vitamin A* dropped? Is it wise to expose yourself to contagious infections in the belief that you are not susceptible to them? Why should a person with a cold isolate himself?

Chapter 11

WHAT YOU SHOULD KNOW ABOUT VITAMIN A

We have largely studied changes which take place when vitamin A is inadequately supplied, but it is actually of far greater importance to know the positive advantages of adequate vitamin A. Provided the diet is well planned in other respects, research indicates that generous amounts of this vitamin can help to give you not only sparkling eyes, glossy hair, healthy skin, and greater freedom from eye fatigue and infections, but also a glow of abundant health.

For glowing skin and glossy hair,
Eat vitamin A enough to spare.

Vitamin A and growth. Adequate vitamin A is absolutely essential for normal growth and development. A stunting of growth does not necessarily mean a lack of vitamin A, but a deficiency of this vitamin during the growth period always

causes poor development. Vitamin A must never be looked upon as essential only to the young. At any age during life, inadequate vitamin A will cause weakening, fatigue, low resistance to disease, and poor vision.

Storage of vitamin A. Vitamin A and carotene are both soluble in fat; that is, they dissolve in fat just as sugar dissolves in water. Since fat is stored in the body, both carotene and vitamin A can be stored, provided excesses are eaten.

Nine tenths of the body's storage of vitamin A proper is held in the liver. The other one tenth is largely in the kidneys and lungs. Excess carotene is stored in the liver and in fatty tissue under the skin. Under normal conditions, the blood always carries both vitamin A and carotene, which are en route to all parts of the body. As the amounts in the blood are withdrawn by the cells, they are replaced from the storage depots.

If you eat generous amounts of yellow and green vegetables and fruits, you can notice that the fat in the palm of your hand, where the skin happens to be rather transparent, will be slightly yellow. This color shows that you have carotene stored for future use. You have money in your health bank.

If you have vitamin A stored, little or no harm can be done during short periods when your diet may lack this vitamin. In this case your reserve supply can be called upon to meet your constant needs.

The advantage of vitamin-A storage. Dr. Booher of the United States Department of Agriculture conducted an experiment with people whose vision was first shown to be normal by tests with the photometer. The group was then given a diet low in vitamin A. Their eyes were tested daily. One of the group showed night blindness on the sixteenth day after beginning the diet. Another had normal vision until the hundred and twenty-fourth day. The first had stored a little vitamin A; the second had stored such large amounts that no ob-

vious harm was done even when she was deprived of the vitamin for three months.

It is known that slight night blindness occurs only when the stored supply of vitamin A is almost exhausted. From the studies with the photometer, it would seem that too large a proportion of the population of the United States have little or no stored vitamin A.

Work with experimental animals has shown that if generous amounts of vitamin A are given, a hundred times more will be stored than is necessary to produce all appearances of good health and to promote ideal growth. In all probability, human beings can likewise store advantageously tremendous quantities, if supplied by the diet.

Babies store relatively less vitamin A than adults unless the diet is kept unusually high in this vitamin. Dr. Wolbach of Harvard believes this inability to store the vitamin efficiently is one reason why babies so frequently suffer from skin rashes and infections, particularly pneumonia. Although authorities urge that cod-liver oil be given as early as the first week of life, frequently it is not begun until the sixth or eighth week. This delay is a serious mistake and is inexcusable.

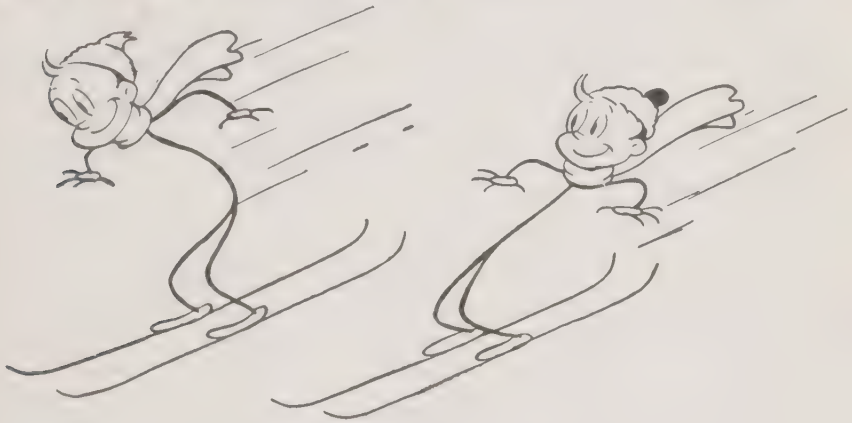
Dr. Sherman of Columbia University writes of stored vitamin A, "We now have good reason to believe that surplus vitamin A in the body is not simply a passive reserve asset to be used at some future time but also actively increases the vigor and the ability of the body to resist disease."

Quantity needed to prevent night blindness. In many experiments, mild degrees of night blindness have been produced by diets low in vitamin A. Various amounts of the vitamin have then been given until just the quantity needed to prevent night blindness has been determined. For adults, the figure has been found to be from 13 to 28 units of vitamin A proper per pound of ideal body weight. When carotene furnishes the

vitamin, usually from 22 to 52 units per pound are needed.

These findings indicate that vitamin A itself is used more efficiently than carotene. They also show that some individuals compared to others need more than twice as much of either vitamin A or carotene per pound of body weight. The adult of average weight needs from 3000 to 8000 units of vitamin A daily merely to prevent night blindness. This amount is spoken of *as the minimum daily requirement.*

Is the quantity of vitamin A which will prevent night blindness identical with that needed to promote ideal health? It



Though sunlight may glare on glistening snow,
It won't bother those whose A is not low.

is known that night blindness develops when the storage of vitamin A is almost exhausted. The quantity of the vitamin which will merely prevent abnormal vision would therefore allow no excess to be stored for use in times of stress.

Influence of infections. During all infections and most illnesses, the body's need for vitamin A is greatly increased. That the stored supply is quickly exhausted is shown by the fact that abnormally small amounts of the vitamin are found in the blood of persons suffering from infections. Blood vitamin A is particularly low in diseases of the liver and kidney, during tuberculosis, pneumonia, and colitis.

Tests with the photometer also show that during infections the vitamin-A supply in the body is quickly used up. The more severe the disease, the more quickly the vitamin appears to be used, and the greater the need for it.

Dr. Thomas Moore of Cambridge University has studied the vitamin-A content of the livers of more than a thousand adults who had died from various causes. In cases of accidental death, 5 grams of liver tissue averaged 1100 units of vitamin A compared with units varying from 0 to 50 for those dying from infections.

Despite the fact that larger amounts of vitamin A are needed during illnesses, patients are frequently given restricted diets which contain almost no vitamin A. A diet deficient in vitamin A is often given even though the lack of this vitamin may have been one of the causes of the illness. It is little wonder that recovery is often slow.

Foods may be chosen for their vitamin-A content as easily during illness as during health. Stewed, perhaps puréed, yellow and green fruits and vegetables should be given to the exclusion of foods such as applesauce and mashed potatoes. Strained fruit and vegetable juices rich in this vitamin could be taken to advantage instead of water. Tasteless capsules of cod-liver or halibut-liver oil, excellent sources of vitamin A, could be given during any illness. Recently capsules of highly concentrated vitamin A made in the laboratory have become available.

The influence of age and sex. Because of growth, children need relatively more vitamin A than adults do; that is, they require more units per pound of body weight. This vitamin is needed in proportion to body weight. Consequently, adults need much larger actual amounts than do children. Since men are usually heavier than women, except in cases where women are overweight, men as a rule need more vitamin A than women do.

Massive amounts of vitamin A. From a practical point of view, it is correct to say that it is impossible to obtain enough vitamin A to be harmful. In an experiment a group of babies were fed 166,666 units of the vitamin daily for five months; not only could no harmful effects be observed but the infants seemed far more healthy than babies receiving smaller amounts. Rats have been given 500,000 units daily throughout their life span, and no toxicity resulted. When still larger quantities are given animals, illness does sometimes result. Similarly, Arctic explorers have become ill after eating polar-bear liver, found to contain as much as several million units of vitamin A per serving. Since no ordinary foods are so rich in the vitamin and sufficient concentrates to supply a million or more units daily would be extremely expensive, the problem is not one of getting too much but of obtaining too little.

Ideal vitamin-A intake. Dr. Wilder of the Mayo Foundation recently pointed out that the requirements of vitamin A are not known, moreover, that they will not be known for years to come because the daily requirements of vitamin A vary with age, ideal weight, degree of health, individual losses from the body, amount absorbed into the blood, season of the year, and the source, whether from vitamin A proper or carotene.

Certainly no exact rules can be laid down. Since an excess can be stored to great advantage and even tremendous amounts are not toxic, it seems wiser to err on the side of eating too much rather than too little.

For years Dr. Sherman of Columbia University has carried on experiments to determine the amount of vitamin A which can be used to advantage by experimental animals. A certain quantity of the vitamin will prevent night blindness and allow the animals the appearances of good health. When that quantity is doubled, tripled, and quadrupled, signs of greater health, greater resistance, and greater vigor are evident, and

the life span of the animals lengthen with each increase. Beyond this point, giving still more of the vitamin brings no further improvements.

Such experiments have not been carried out with people. Until further information is available, however, the same principle may well be applied to them. In the column at the left of the following table are the amounts of vitamin A recommended by the Food and Nutrition Board of the National Research Council; these quantities will prevent night blindness and allow the appearances of health. If Dr. Sherman's findings are applied and these quantities are multiplied by four, then we arrive at figures which may approximate

	RECOMMENDED DAILY ALLOWANCES	PROBABLE IDEAL ALLOWANCES
men	5,000	20,000
women	5,000	20,000
girls 13 to 20	5,000	20,000
boys 13 to 15	5,000	20,000
16 to 20 years	6,000	24,000
children under 1 year	1,500	6,000
1 to 3 years	2,000	8,000
4 to 6 years	2,500	10,000
7 to 9 years	3,500	14,000
10 to 12 years	4,500	18,000

the ideal amounts to promote perfect health. These figures are given in the right-hand column.

Many people will say that these figures are too high, but probably for ideal health they are actually too low, especially for young babies who have no stored vitamin A. In the long run, you alone can make your choice. How high are your ideals for health?

Case Histories

1. *Albert C.* was a tall, thin boy who suffered from severe sinus infection and was rarely free from headaches. Despite the fact

that his sinuses had been operated on and drained several times, the vitamin A in his diet had not been increased.

His diet was then revised. The fruits and vegetables were restricted to green and yellow ones. He not only ate raw carrots and dried apricots daily but also drank quantities of carrot juice. Gradually he showed improvement. There was less drainage into his throat. He could breathe through his nose, and the pain was markedly decreased.

After some time not only were his palms yellow, but the tip of his nose was also yellow. His skin had a healthy glow which would lead one to think he had been vacationing in Florida. When Albert was studying for midwinter finals, he missed much sleep. He caught a severe cold. Four days later there was not a trace of yellow to be seen even in his palms. His cold, however, disappeared with amazing quickness, and his sinuses did not become reinfected.

2. *Helen A.* was a high-school student who, besides studying a great deal, especially enjoyed reading. Her eyes sometimes ached and the lids smarted and burned.

Helen's mother went with her to an oculist who carefully examined her eyes and tested them with a photometer. He found that she did not need glasses but that she was extremely deficient in vitamin A. He outlined a diet unusually rich in this vitamin and, in addition, asked her to take a concentrate of carotene in gelatine capsules.

In two weeks Helen returned to the oculist to have her eyes examined again. The photometer reading was the same as before. She complained that her eyes felt very little better. A month passed and still there was no improvement.

One morning Helen's mother called her physician to say that Helen had passed a bright red substance with the feces. It could not possibly be blood, she assured him; it appeared oily.

After much questioning the physician learned of the carotene capsules and discovered that the mother, who was trying to reduce, was making salad dressing out of mineral oil and had served it to the entire family. Helen had been told to eat many green salads, and had, therefore, consumed generous amounts of the dressing. Since the carotene from digested foods and that

which she had been taking in capsules dissolves readily in oil, it had dissolved in the mineral oil and was being lost from the body. As soon as Helen discontinued using the mineral-oil salad dressing, her eyes improved rapidly.

Projects

1. Compare the color of the palms of students in the class. Can you notice that some are more yellow than others? Select ten members of the class who will agree to eat such foods as apricots, carrots, parsley, and other colored foods daily. After three weeks, compare the color of palms again. If no color is evident, what would be your conclusion?
2. Look in advertising material, other texts, and whatever sources you can find for suggested requirements of vitamin A. How many give quantities which would merely prevent night blindness? Is it wise to mislead the public into believing that this quantity is all that is needed?
3. Conduct an animal experiment following the directions on page 473. As the experiment progresses, observe the differences in weight, color, energy, cleanliness, temper, posture, texture of fur, and brightness of eyes. When the animals which are inadequately fed look as if they might die, add vitamin A to their diets. Can a poor diet during the growing period ever be completely overcome?
4. Pick out an individual who, in your opinion, has eaten optimum amounts of vitamin A. Give all the reasons for your conclusions.
5. Make out a day's menus for a person suffering from any infection or infectious disease. Try to include 100,000 units of vitamin A.

Topics for Discussion

1. What does yellow color in the palm of the hand indicate? Does lack of color indicate lack of vitamin A? Why?
2. What is the advantage of stored vitamin A? When night blindness exists, what is the condition of the storage depots? Name several influences which cause variations in the amount of vitamin A stored.
3. Why do the requirements of vitamin A vary so widely between individuals? Why do you require more vitamin A at one time

than another? Why is it unwise to lead the public into believing that minimum requirements are identical with ideal requirements? Discuss the statement, "Your vitamin-A requirements are as varied as your activities." List your activities for one day and tell why one activity uses up more vitamin A than another.

4. Does the body need vitamin A to help fight infections?

Chapter 12

THE SOURCES OF VITAMIN A

Tables of the vitamin-A content of foods can give only approximate values. One sweet potato or carrot is more yellow than another. No two heads of lettuce or cabbage are green to exactly the same degree. If you look over a number of tables giving units of vitamin A, you will probably find no two tables exactly the same. For example, according to one table the units for tomatoes may be those found in one laboratory for a given variety of tomatoes of a certain ripeness. Another table might give units determined at an entirely different laboratory for another variety of tomatoes which were less ripe. Both figures are correct for the sample of food used in determining the vitamin-A units. Even when you carefully calculate the units of vitamin A you have eaten in a given day, your results can be only approximate.

Vegetable sources of vitamin A. Carotene is closely associated with the green coloring of plants called *chlorophyll*. The greener the plant, the more carotene it contains. Green leaves, therefore, are especially rich in vitamin A. For example, the outer green leaves of lettuce or cabbage usually contain thirty times more vitamin A than the pale inner leaves.

The carotene content of a plant increases up to the time of flowering. Then it is gradually destroyed. You have probably noticed that broccoli in bud has greener leaves than that which has begun to flower. As leaves fade, the loss in carotene is proportional to the degree of fading. When they are brown and dry, no vitamin A remains.

Green leaves such as parsley, watercress, kale, spinach, and Chinese cabbage are our richest sources of carotene. Pods like those of green peppers, string beans, and edible-pod peas also contain generous amounts of vitamin A, as do stalks such as unbleached celery and asparagus.

The amount of carotene is also proportional to the color of such foods as carrots, yellow squashes, rutabagas, yellow melons, apricots, peaches, and other yellow fruits and vegetables.

Foods which have been green, such as ripe olives, tomatoes, berries, plums, and prunes, have lost much vitamin A but still retain some. Although apples and pears have been green when small, practically all the vitamin A is lost by the time the fruit is ripe.

Vegetable foods which have never been either yellow or green are devoid of vitamin A. Examples are Irish potatoes, white turnips, beets, cauliflower, radishes, eggplant, celery root, parsnips, and navy beans. Rice, wheat, and other cereal grains except yellow corn and wheat germ lack vitamin A. Foods which have completely lost their green color, as dried lima beans, bleached asparagus and celery, and winter onions, have also lost the carotene they once contained.

Animal sources of vitamin A. Foods of animal origin vary even more in vitamin A than do fruits and vegetables. For example, liver may be extremely rich in vitamin A or devoid of it, depending upon the food eaten by the animal from which it came. The animal fed on green grass or alfalfa will have much vitamin A in its liver. The one given only dry hay may have little or none.

The amount of vitamin storage also depends upon age. At the beginning of World War II, a number of the more dangerous animals in the London Zoo had to be put to death, lest they might be set free as the result of bombings. The livers of these animals were analyzed for vitamin A. The richest source

of the vitamin ever determined was the liver of a python estimated to be more than a hundred years old. Similarly, halibut-liver oil is much richer in vitamin A than is cod-liver oil, because the halibut is much older than the cod when marketed. The halibut has had a longer time to store the vitamin. Given the same food, a mature animal would store larger amounts than a young animal; hence its liver would be an excellent food source. For this reason beef and mutton liver usually contain more vitamin A than that of calf or lamb. The liver of beeves and other animals fattened on grass contains more vitamin A than that from hogs and other animals fattened on grains.

Kidneys, heart, sweetbreads, and lungs contain appreciable amounts of vitamin A, provided the food of the animal has been good. Since this vitamin is not stored in muscles, muscle meats used for chops, steaks, and roasts lack vitamin A.

Vitamin A in dairy products. Eggs and milk always contain some vitamin A. If the vitamin is lacking in the food given hens and cows, their stored vitamin is called upon to supply that in egg yolks and butter fat. When these storage deposits are nearly depleted, hens lay fewer eggs, and cows produce less milk. This decreased production is not likely to occur, however, because the adequate feeding of farm animals is too often considered of greater importance than the adequate feeding of humans.

There is much variation depending upon the animals' diets. An experiment was carried out on two groups of cows, one given little vitamin A, the other abundant amounts. The milk from the first group averaged 500 units per quart; from the second, 7000 units. Market milk, which is largely from dairies where cows are usually well fed, averages about 3000 units per quart. Similar experiments on hens show that the vitamin A in egg yolk can be tremendously increased by good feeding.

Eggs and milk contain both carotene and vitamin A proper.

Jersey and Guernsey milk is relatively rich in carotene, but other breeds produce milk low in carotene and rich in the colorless vitamin A. The color of milk, cream, or butter is not necessarily an index of the amount of the vitamin A contained. Winter butter, produced when the cows are given dry feed, may contain only 2000 units per pound. Summer butter averages about 12,000 units per pound. It is therefore better during the winter to eat storage butter, produced during the summer, than winter butter. In experiments where cows have been given fish-liver oils with their feed, butter containing 40,000 units per pound has been produced.

The effect of oxygen on vitamin A. Vitamin A and carotene are both destroyed by combining with oxygen. The peeling on foods helps to prevent contact with oxygen and to preserve the vitamin-A content. It is best to cook such foods as yams, sweet potatoes, yellow turnips, and carrots with the peeling on. When it is necessary to peel them, the peeling should be done just before cooking. If foods must be peeled long before cooking, they should be carefully covered from air and stored dry in the refrigerator.

The effect of cooking on vitamin A. The combination of vitamin A and oxygen is a chemical process accelerated by heat. Therefore, vitamin A is destroyed much more quickly during cooking than while the food is kept under refrigeration. You have seen fresh green peas, beans, or green leafy vegetables change to a dull gray when improperly cooked or overcooked. The loss of vitamin A is parallel to the loss of color.

If butter is used in frying, the high temperature destroys most of its vitamin A. Cheaper fats might better be used for this purpose. In order to preserve the vitamin, butter should not be added to vegetables until they are ready for the table.

Reheating destroys even more vitamin A than the original

cooking. Leftover vegetables might better be used in salads. When foods must be kept warm for long periods, as in restaurants or cafeterias, large amounts of the vitamin A are destroyed. For this reason people who must eat in restaurants are almost invariably deficient in vitamin A.

Effect of canning, freezing, and drying. Canning causes very little loss of vitamin A. Since hot water or syrup is added directly to the foods, which are then sealed against oxygen, and cooked, such foods contain more vitamin A than wrongly prepared home-cooked foods. Some vitamin A is destroyed when canned foods are opened and then heated. It is better to heat foods in the can.

Quickly-frozen fruits and vegetables retain most of their vitamin-A content. After the food has thawed, destruction of the vitamin is rapid; hence these foods should be cooked or eaten as soon as thawed.

Cold-storage food is kept at a much higher temperature than frozen foods. There is a loss of vitamin A, the amount depending upon how long the food has been stored and how completely it is covered against contact with air. Cold-storage peaches and apricots, for example, usually lose much of their color.

Sulphur-dried fruits retain most of their vitamin A. The sulphur-drying process is so rapid that it allows little time for oxidation to take place. The slow sun-drying process causes much of the vitamin to be lost. Contrary to popular opinion, the sulphur used is in no way harmful.

Your garden and vitamin A. Every garden should be planned to produce as much vitamin A as possible. Carrots, spinach, sweet potatoes, green beans, bell peppers, peas, and other vitamin-A-rich vegetables should be planted in larger amounts than parsnips, white turnips, and beets. Celery and asparagus should be left green. Whenever conditions permit,

watercress should be grown. No garden is complete without its row of parsley. A well-planned garden can produce an abundant supply of vitamin A. The wise person plants such a garden and is generously rewarded by seeing greater health in each member of his family.

Projects

1. Have each member of the class look up ten recipes for preparing foods containing vitamin A. Criticize each recipe. Is any vitamin A needlessly destroyed or thrown away? How could the recipes be modernized?
2. Send for seed catalogues and search for little-known or recently developed vegetables likely to be rich in vitamin A. If you have a garden at home, influence your family to plant a wide variety of these vegetables.
3. If it is possible, plant a garden in the school yard. Choose little-known vegetables. When the vegetables are ready to eat, work out palatable ways of preparing them.

Topics for Discussion

1. Why do tables giving vitamin units often vary widely? Give examples of variations you have observed in the colors of green or yellow foods.
2. How can you tell by observation the approximate vitamin-A content of fresh foods, storage foods, wilted leaves, and cooked foods?
3. Why is halibut-liver oil richer in vitamin A than cod-liver oil? Which probably contains more vitamin A, calf or beef liver? Why?
4. How do the following affect the vitamin-A content of foods: oxygen; cooking; drying; canning; freezing; and cold storage?
5. How can foods be best prepared to preserve their vitamin-A content? What improvements can you make at home to save vitamin A in your foods?

Chapter 13

YOUR NEED FOR THIAMIN

The vitamin once called *vitamin B* was in reality a group, of which several are made in chemical laboratories. These synthetic vitamins are identical with those produced by nature and are used as efficiently in the body. Not all vitamins which experimental evidence has proved to exist have been made chemically, however. The entire group apparently contains ten or more vitamins and is spoken of collectively as the *vitamin-B complex*. These vitamins occur together in natural foods, although some foods are richer in one than another.

The B complex is meagerly supplied in our diet. The vitamins in foods which could be our most reliable sources, breads and cereals, have been discarded in refining. As a result, it is probably correct to say that every group of persons in America, young or old, rich or poor, could profit by generous additions of these vitamins to their diet.

The best understood member of the group was formerly called *vitamin* B_1, but is now known by its chemical name, *thiamin,* or *thiamin chloride.*

Sources of thiamin. Thiamin is necessary for the sprouting of seeds. Therefore, it is found, together with other members of the complex, in all foods which are in reality seeds. Examples are all cereal grains, nuts, dry beans and peas, soybeans, and legumes and all articles of diet prepared from these foods, such as peanut butter and unrefined breads and cereals. Among our sources of animal origin are liver, kidney, and heart. Pork meat contains from three to five times more thia-

min than do other muscle meats. The richest sources are foods which are not often eaten daily: wheat germ, liver, rice polishings, and powdered yeast.

A child's breakfast which shows planned nutrition: fresh orange juice, bananas with whole-grain cereal and milk, egg, whole-grain bread and butter.

Beriberi. The disease produced by a deficiency of thiamin is known as *beriberi.* It has been the scourge of the rice-eating people of the Orient for years. The disease is characterized by digestive disturbances, loss of weight, and painful neuritis, which may cause paralysis. The hearts of people with beriberi are abnormal and frequently become enlarged. People have died from the disease by the thousands, not from beriberi itself but from heart failure.

Beriberi was produced experimentally by Dr. Eijkman in 1897. He had first noticed that pigeons given polished rice which was left from the hospital table developed a disease similar to that suffered by humans. When unpolished rice

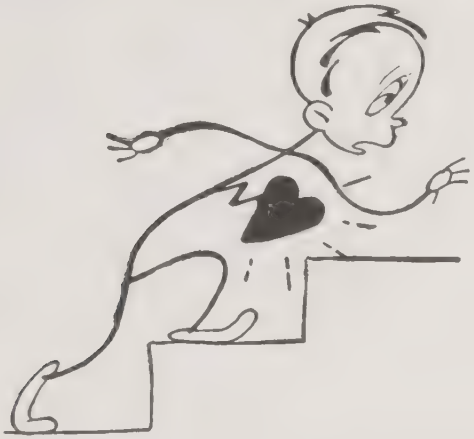
was given, the disease in pigeons could be prevented or cured. The first vitamin was thus discovered.

Although the number of deaths reported in the United States from beriberi is relatively small (about 40 a year) outstanding authorities agree that the American diet supplies very little more thiamin than is needed to prevent this disease.

Production of thiamin deficiencies. Dr. Jolliffe of New York University School of Medicine made a study of five volunteers who lived on a diet adequate in all respects except that it contained little thiamin. After staying on the diet only four days, these people noticed that they were unusually fatigued. They lacked appetite, and became constipated and extremely depressed. As they continued their inadequate diet, the fatigue and mental depression became more exaggerated. Soon they noticed that on the slightest exertion they had difficulty in getting their breath. They were aware of the beating, or palpitation, of their hearts. Dr. Jolliffe carefully studied the hearts and found they were abnormal in each case except one. Adequate thiamin was then given the subjects. The symptoms disappeared in from three to six days.

Two longer experiments were carried out at the Mayo Foundation. In both studies, four young women lived on diets almost lacking thiamin for twenty-one weeks. These women quickly developed extreme fatigue, mental depression, lack of appetite, loss of weight, and digestive disturbances such as gas pain and constipation. They became anemic and were nervous, irritable, and unable to sleep well. It was found that they had very little hydrochloric acid in their stomachs. In some cases there was a complete absence of this valuable acid. As time went on, they developed a soreness and tenderness in their legs which are recognized as the first symptoms of neuritis. Their hearts became abnormal and in a few cases were enlarged. In other words, by the simple means of a diet inade-

quate in thiamin, heart disease was developed. The young women became so exhausted that it was impossible for them to carry on their work. By the twenty-first week nausea developed in all eight cases, followed by such extreme vomiting that the experiments had to be terminated.



"If this guy that I'm in," said the heart without levity,
Would get more B_1, he'd increase my longevity."

Thiamin was then injected into the veins. Within a few hours the women's appetites were normal, they became cheerful, and the feeling of fatigue left them. Other symptoms disappeared more slowly. The flow of hydrochloric acid was found to be normal in twelve days. Because of the length of the experiment, the heart disease was more severe than that produced in the New-York group. The hearts were not normal until after fifteen days of the thiamin treatment.

The function of thiamin. Thiamin might be called the "pep" vitamin. An increase in this vitamin from a meager to an abundant intake results in greater vigor and endurance. When it is inadequately supplied, fatigue quickly results. The extent of the fatigue depends on the severity of the deficiency. The reason is that thiamin is a necessary part of an enzyme system

used in helping the body to burn sugar to produce its energy.

In the production of energy, sugar is torn down in the cells by a series of chemical changes. At one step in this process, substances called *pyruvic* and *lactic acids* are formed. In the presence of thiamin, these acids are quickly used in producing energy and changed to carbon dioxide and water. In the absence of thiamin these acids cannot be broken down. They accumulate in the brain, nerves, heart, and blood, and are thrown off in the urine. The production of energy from sugar comes to an abrupt stop. Since energy is not produced efficiently from fats unless they are burned with sugar, fatigue results. There is a general slowing down throughout the entire body.

Thiamin and endurance. The person who lacks thiamin is lazy. He tires easily. He "can't take it." The athlete, if he be really first class, must have more than an ample supply of thiamin. The best dancers, the distance swimmers, and the mountain climbers also need an abundant supply.

In an experiment, several students were given a diet containing 1 milligram of thiamin daily. To test their capacity for work, they lifted weights until they were fatigued. The diet was increased to include 2 milligrams of thiamin but remained the same in other respects. They then lifted the weights twice as many times without fatigue. The simple increase in thiamin doubled their capacity for work without undue tiring.

The value of additional thiamin when great physical strength is needed was shown by experiences of mountain climbers. Many attempts have been made to climb Mount Everest, all of them unsuccessful. Above 23,000 feet, the climbers not only suffered distressing fatigue and shortening of breath, but lacked appetite to such an extent that they could scarcely eat food of any kind. Like the experimental group lacking thiamin, they suffered from nausea and vomiting. These symptoms were

Vivacity and vitality which make for popularity are attributes of good nutrition.

laid to the rarefied air of the high altitude. An expedition of 1933 consulted a nutrition expert concerning the food to be taken on their trip. Their diet was made much higher than usual in thiamin. This time, at the altitude where climbers formerly became ill, they suffered from hunger rather than

from lack of appetite. Nausea, vomiting, and extreme fatigue came later when the supply of thiamin in their improved diet was still too small to furnish the amount needed for such extreme physical endurance.

Thiamin and overweight. The lack of thiamin causes a marked decrease in the production of digestive enzymes. When too few starch-splitting enzymes are secreted, starchy foods which should yield sugar are not completely digested. Less sugar is freed to pass into the blood. Needless fatigue results, together with a craving for sweets. Such people eat large amounts of sweets and candies containing sugars which can be absorbed without first being broken down by enzymes. In this way, a slight deficiency of thiamin often leads to excessive overweight.

Thiamin and appetite. An undersupply of thiamin quickly results in a loss of appetite. Poor appetite associated with thiamin deficiency is extremely common in babies and children. It is less frequently noticed by adults, who usually eat from force of habit even when they are not hungry.

Thiamin-deficient children whose parents plead with them to eat often have excellent appetites a few hours after ample thiamin is given them.

It must be stressed that while vitamins of the B-complex help to change a poor appetite into a normal one, no amount of vitamins can increase a normal appetite to an excessive one. In fact, an excessive appetite usually indicates an inadequate diet.

Thiamin and heart action. In experimental animals the heart is the first organ to suffer when thiamin is inadequately supplied. In rats, the normal heart rate is about 500 beats a minute. A complete lack of thiamin causes it to slow to from 200 to 300 beats a minute within three days. This change is so consistent that it is used as a method of determining the

amount of thiamin in foods. A deficiency is first produced. When the pulse is about 300 beats a minute, a weighed sample of the food to be tested is given. If the heart rate does not change, the food lacks thiamin; if it speeds up, the food contains the vitamin, the amount depending on the length of time the heartbeat stays normal.

If you're winded and pant after sprinting a block,
Of your vitamins B you had better take stock.

Of all parts of the body, the heart alone must work continuously from birth until death. When sugar cannot be changed efficiently into energy, as it cannot when thiamin is lacking, the heart slows down. In such cases a pulse of 40 or 50 beats a minute is not uncommon, instead of the normal heart rate of 72.

As the vitamin deficiency becomes more severe, the pulse changes from slow to rapid. This change is believed to be due to the irritation of the heart muscles from the accumulation of lactic and pyruvic acids. The person with such a deficiency becomes conscious of the racing beat of his heart. He is short winded and has difficulty in getting his breath on slight exertion. His heart may become enlarged. His blood pressure usually falls below normal, allowing the blood to flow slowly through the body; therefore food and oxygen are not efficiently supplied to the cells. As the condition increases in severity, the

symptoms become exaggerated, and the person may suddenly die of heart failure.

Patients with many types of heart disease considered to be unrelated to the lack of thiamin have been found to have abnormally small amounts of the vitamin in their blood and urine. Lactic and pyruvic acids, which accumulate only in the absence of thiamin, have been found in larger than normal amounts in the blood of such patients. Such findings indicate that lack of thiamin is more often associated with heart disease than is recognized; that in any type of the disease, the diet should be kept unusually rich in this vitamin.

There is no doubt that you who wish to go through life with strong, sound hearts must carefully plan your diets to include generous amounts of thiamin.

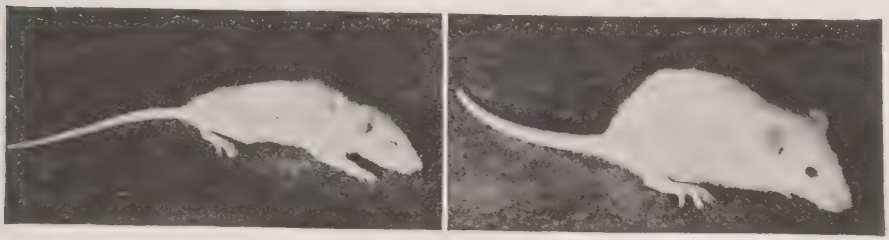
Thiamin and the nerves. When thiamin is inadequately supplied, neuritis frequently develops. In mild cases, the pain appears to be due to the accumulation of lactic and pyruvic acids from incompletely burned sugar. In more severe cases the nerves may be actually damaged.

Nerve cells are particularly affected by the lack of thiamin because they can burn only sugar to supply their energy; other cells can derive energy from either fat or sugar. Since the brain is nerve tissue, lack of thiamin causes mental depression and sluggish thinking.

Thiamin and digestion. The lack of thiamin causes profound changes throughout the entire digestive tract. Aside from a loss of appetite, the less vigorous contractions of the stomach prevent food from being well mixed with digestive juices. At the same time, hydrochloric acid is secreted in small amounts or may be absent. Mucus, which protects the delicate walls of the stomach and intestines, is produced in smaller amounts. The flow of bile and pancreatic and intestinal juices is decreased. Fewer digestive enzymes are produced. Foods

are, therefore, incompletely digested in the small intestine and cannot be well absorbed into the blood.

There are always millions of bacteria in the intestines. The more food left undigested, the greater the number of bacteria which can grow on this undigested food. Gas is formed in the bacterial breakdown of undigested food. Distention and gas pain result. The contractions of the muscular walls of



Prolonged deficiency of thiamin checks growth in young animals, causes loss of appetite, and results in degenerative changes in the nervous system. At the right is the same animal as that shown on the left, after having been cured by administration of thiamin.

the small intestine become infrequent. The food mass, like that in the stomach, is less well mixed with digestive enzymes and juices. Fewer particles of digested food are brought into contact with the absorbing surfaces of the walls.

Such a condition is frequently responsible for the inability to gain weight even though a high-calorie diet is eaten. Yet, it does not follow that ample thiamin is fattening to the person whose weight and absorption are already normal. If foods are completely digested and absorbed, additional thiamin has no effect on digestion. When thiamin is generously added to the diet of the person lacking it, digestion gradually becomes normal.

Thiamin and elimination. Just as the heart and muscular movements of the small intestine slow down when thiamin is inadequate, so are there fewer contractions in the large intestine. Lack of movement prevents the wastes from being

pushed on toward the rectum. Waste materials stay in the large intestine longer than they should. Since the purpose of the large intestine is to conserve water, the longer the wastes remain there, the harder and drier the feces become. This condition is called constipation.

He takes castor oil; it's easy to see
That the thing which he lacks is vitamin B.

Faulty elimination is so common in the United States that the American people are said to spend more for laxatives and cathartics each year than for education. Yet many cases of constipation are quickly relieved when an adequate diet rich in vitamins of the B complex is given. Cathartics may be harmful, needless, and palliative rather than corrective.

A major need of every cell. Every cell in the body can produce energy for its own life processes most efficiently from sugar. Sugar cannot be burned completely unless thiamin is amply supplied. Every cell, therefore, needs its quota of this vitamin.

The nerves and brain can use only sugar to produce energy; the heart muscles must have a continuous supply of energy; therefore, these tissues are the first to be harmed by the lack of thiamin. The abnormalities which cause indigestion and con-

stipation are largely indirect rather than direct results of too little thiamin.

The vitamins of the B complex are more difficult to obtain from ordinary foods than other vitamins are. Special effort and planning, therefore, are required if these vitamins are to be amply supplied in your diet. Their immediate value to you now and their contribution toward ideal health cannot be overemphasized.

Case Histories

1. *Marshal T.* was a well-built, handsome senior and the star player of the football team. During his four years in high school he had participated in almost every type of athletics. In the fall of his senior year he went with his mother to consult a physician. As Marshal expressed it, he couldn't take it any more. He was tired all the time; he cared little to eat and was troubled with constipation. He had lost his wind. His fatigue after football practice was extreme. His pulse was 48 beats a minute. The physician found that his heart was enlarged. Although he had been eating somewhat more thiamin-rich foods than many people, his requirements were extremely high. He had been in athletics year after year; yet never once had he been told that violent exercise increased his needs for many essential nutritive elements.

   His symptoms were quickly corrected by an adequate diet extremely rich in the vitamins of the B complex.

2. *Nina M.* majored in Home Economics in high school, because she liked to cook and especially to eat the food they prepared in class. She was not particularly interested in health. She felt all right; as good as anyone, she supposed.

   When she computed the amount of thiamin she had obtained in one day, she found it to be 1.68 milligrams. To her, that proved that larger amounts were not necessary.

   As a class project, each student was asked to plan and eat a diet which contained 5 milligrams of thiamin every day for a week. Nina did so, but quite without interest. At the end of a week, however, she noticed a difference. She had more "pep," more

drive, a feeling of unusual enterprise. She was amazed to find that facts taught in class really worked when they were applied. It was not until this time that Nina realized that there are degrees of health, and that she had considered herself well merely because she had not experienced feeling better.

Projects

1. Check the amounts of thiamin you have obtained from foods eaten in twenty-four hours. Compare this amount with your ideal requirement as suggested on page 186. Could you use more thiamin to advantage?
2. Ask a number of people the following questions: Are you usually tired? Do you crave sweets? Are you easily depressed? Are you short winded? Are you conscious of your heartbeat on slight exertion? Have you trouble with poor elimination, gas, or indigestion? Can you find anyone who does not appear to have at least one symptom of a thiamin deficiency?
3. Have each member of the class take his pulse. The beats can be counted for 15 seconds and multiplied by four. Does anyone have a pulse rate below 72 beats per minute? If so, take the pulse again in a few days after foods rich in the vitamin-B complex have been added to the diet. Is any change noticed?
4. If you know anyone with heart trouble, calculate his intake of thiamin for twenty-four hours. Find out if he has habitually eaten foods rich or poor in this vitamin. Do the same for anyone you know who suffers from faulty elimination, neuritis, indigestion, or gas distention.
5. Feed two rats identically except that one be given white bread and the other 100 per cent whole wheat. Follow directions given on page 473. How soon do you notice a difference in elimination? Weigh the animals each week. After three or four weeks, carefully anesthetize the animals. If some student in the class wishes to be a surgeon, let him cut open the abdomen and remove the ribs, to expose the beating heart. Can you observe any differences in the contractions of the intestinal tract? By the use of a stop watch, count the number of heartbeats of each animal. What difference do you find? Remove the hearts and compare as to size.

6. Plan and eat a diet containing 5 milligrams of *thiamin* daily for a week.

Topics for Discussion

1. What foods would you suggest for a child who lacks appetite? Why should such a child never be given sweets?
2. Why are the following especially affected by a deficiency of thiamin: the brain; heart; nerves; intestinal tract? Why do indigestion and gas production result from the deficiency?
3. Why can thiamin often help the underweight person to gain and still have no effect upon the person whose weight and digestion are normal?
4. What part of a milligram is each of the following amounts in gammas: 0.6; 3; 68; 250? State the following in gammas: 0.581 milligram; 4.362 milligrams; 1.25873 grams. How many gammas and milligrams are: 250 units of thiamin; 666 units of thiamin? See page 441.

Chapter 14

YOUR NEED FOR RIBOFLAVIN

In 1926 it was found that if foods rich in vitamin B were heated under pressure for a number of hours, they no longer cured beriberi; but they were still valuable in clearing up other conditions. The vitamin not destroyed by heat was given the name of *vitamin B_2,* or *G.* In 1934 this vitamin was made chemically, or synthesized, in the laboratory. It is now known by its chemical name, *riboflavin.*

Like carotene, riboflavin is a coloring pigment. It is the yellow-greenish substance which can be seen in egg white, whey, and powdered skim milk. When people speak of skim milk as being blue, the cream containing the carotene has been sufficiently removed to allow the greenish color of riboflavin to become visible.

Sources of riboflavin. Generally, riboflavin is found in the foods which are rich in the other vitamins of the B complex. It is not rich in cereals and it is abundant in milk and eggs, which contain little thiamin. Liver is the richest known source of riboflavin, and yeast runs a close second.

Riboflavin is formed in green leaves during growth, and like vitamin A, it is lost when the leaves become dry and withered. Unlike carotene, riboflavin is not stored in fruits, roots, or tubers. Among the vegetables, beet and turnip greens, carrot tops (which should always be used in soups), broccoli leaf, and kale are among the richest sources. Mustard greens, spinach, watercress, and New Zealand spinach are somewhat less rich but are still excellent sources. Green leaves contain almost

twice as much riboflavin as green stems do. The inside leaves of cabbage and lettuce contain only about one fifth as much of this vitamin as the outside leaves.

The limited amount of riboflavin which does occur in grains is mostly lost when they are made into white flour and refined cereals.

When you try to play games and you have no endurance,
A supply of B complex is your best insurance.

Function of riboflavin. Like thiamin, riboflavin aids the body in the burning of sugar to produce energy. It must be remembered that each cell produces energy for its own life processes, and that muscle cells produce additional energy for body activities.

Riboflavin, combined with protein and phosphoric acid, forms enzymes necessary in the breakdown of sugar. Five enzymes containing riboflavin are known. When riboflavin is inadequately supplied, energy is produced inefficiently. The person lacks pep and endurance and suffers from fatigue.

Riboflavin deficiency in humans. Dr. Sebrell and Dr. Butler of the United States Public Health Department conducted an experiment in which eighteen young women stayed on a diet lacking riboflavin. In from three to four months the oil-producing glands in the skin of the face became abnormal. The

skin of the nose, chin, and forehead took on an oily appearance, and fatty deposits accumulated under the skin. In due time, thirteen of these women developed red, sore lips which cracked and peeled. The corners of their mouths and eyelids also became sore and somewhat swollen. As the condition became worse, crusty, oily scabs formed on the upper lips and at the base of the nose.

This condition had been so frequently observed in the South associated with a disease known as *pellagra* that it was considered part of that disease. The pellagra-preventing vitamin, also part of the B complex, was given these women, but their eyes and lips became worse. When riboflavin was given them, the condition was corrected.

Dr. Sydenstricker of the Medical School at the University of Georgia has stated that lack of riboflavin appears to be the most common single vitamin deficiency which exists in this country.

Riboflavin deficiency in animals. A lack of riboflavin, like that of thiamin, first causes loss of appetite, decrease in energy, and loss of weight. In rats, a lack of riboflavin causes the eyes to become dull, and opaque spots to appear in them.

In experiments carried out by Dr. Day of Columbia University, 100 per cent of the rats lacking riboflavin developed cataract. If riboflavin was not then given them, complete blindness resulted.

Cataracts have been produced in the eyes of mice, chickens, monkeys, geese, and even fish by diets which are adequate in every respect except for riboflavin. If riboflavin is given the animals before the condition is too advanced, the eyes again become normal. If the deficiency becomes too severe before the vitamin is added to the diet, the disease does not progress farther, but the damage already done cannot be repaired.

Riboflavin and the eyes. Dr. Sydenstricker of the University of Georgia also made a study of forty-seven patients suffering

from lack of riboflavin. Eighteen of these patients appeared to be well nourished and had apparently lived on an average diet. Half of the cases showed no soreness of the corners of their lips and eyelids. All of these patients complained of visual disturbances to such a degree that a special study was made of their eyes. All were sensitive to light and suffered from dimness of vision, faulty vision in poor light, and eyestrain which could not be corrected by glasses. They complained of burning sensations in the eyeball, extreme visual fatigue, and a feeling of roughness as if grains of sand were under the eyelids. Their eyes watered easily. Six of the patients suffered from cataract. Eighteen others showed opacities which indicated the beginning of cataract.

The most common symptom was a tendency of the eyes to become bloodshot. The thin covering over the entire eye normally contains no blood supply. In many cases of riboflavin deficiencies, however, blood vessels developed to such an extent that they could be seen without a magnifying glass.

The eye symptoms did not improve when cod-liver oil was given, a fact which showed that they were not due to a vitamin-A deficiency. When 5 to 15 milligrams of riboflavin were given daily, a marked change was noticed. In many cases, the sensitiveness to light was relieved in twenty-four hours. The burning, itching, and feeling of roughness of the lids often disappeared in two days. By the use of sufficient riboflavin, the eyes of all the patients, including those who suffered from cataract, became normal in every respect.

After being completely cured, a few of the cases were put on a diet which contained no riboflavin. The eye symptoms soon returned. Again they were corrected by riboflavin.

Dr. Wolbach of Harvard University School of Medicine has carefully studied the changes in the eyes caused by riboflavin deficiency. He believes that, under normal conditions, ribo-

flavin combines with oxygen in the air and carries it to the surface covering of the eye, which is not supplied with oxygen from the blood stream. When riboflavin is not adequate, the eye suffers from insufficient oxygen; therefore, blood vessels are formed to bring oxygen directly to the eye tissues and cause the eyes to look bloodshot.

It should be emphasized that patients such as these suffered from conditions which are frequently found and for which glasses are often prescribed. The majority of oculists and optometrists do not test the eyes for deficiencies of either riboflavin or vitamin A. In deficiencies of both of these vitamins, a test with a photometer shows the eyes to be abnormal.

At any time when vision is poor, vitamin A and riboflavin should be abundantly supplied in the diet. Since younger people usually drink milk rich in riboflavin, a sensitiveness to light in their case most often indicates a vitamin-A deficiency. The reverse is true of older people. Deficiencies in riboflavin and vitamin A may occur at the same time.

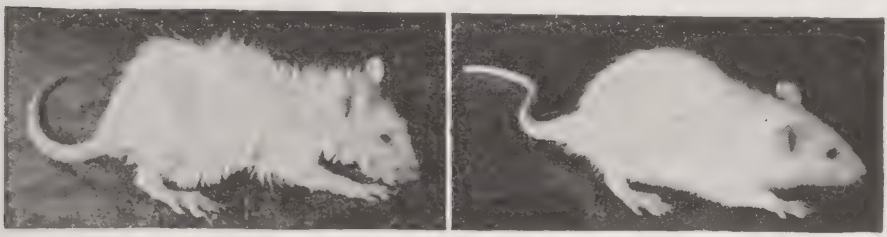
Losses of riboflavin. Like the other vitamins of the B complex, riboflavin is soluble in water. It cannot, therefore, be stored in the body, and is lost in the urine and perspiration. The excretion is greatly increased when massive doses are eaten and not needed.

Since riboflavin is needed for the existence of life itself, the body tenaciously holds on to its supply when the diet furnishes little. A third of the quantity normally found in the bodies of animals still remains even though they have died from a riboflavin deficiency.

Riboflavin is not harmed by oxygen and therefore is not affected by cooking although it is easily lost in the water in which foods are prepared.

The advantages of ample riboflavin. Dr. Sherman of Columbia University has studied extensively the effect of ribo-

flavin upon the health of experimental animals. He has found that a certain amount of riboflavin is needed to prevent all signs of a deficiency and to give all appearances of good health. As in the studies of vitamin A, when that amount is doubled, tripled, and even quadrupled, each increase brings a higher level of well-being, more evidences of positive health, and



Deficiency of riboflavin affects growth and also induces certain changes in the skin. At the right is the same animal after having been cured by administration of riboflavin.

greater vitality. The animals have higher resistance to disease; they produce more and healthier offspring; the onset of senility comes at a much later age; and the life span is dramatically increased.

A human parallel to his experiments have, in the past, been found in Bulgaria. The people are outstandingly healthy. Their diet consists largely of black bread and sour milk, which are both rich in riboflavin. Although the population is small, more of the people live to be centenarians than among any other nation. They retain their characteristics of youth to a late age. Work with experimental animals indicates that these qualities are the result of their high-riboflavin intake throughout life.

In the years to come, when you will probably take less exercise than now, eat fewer calories, and perhaps begin to put on unwanted weight, you must guard against allowing your intake of riboflavin to become too low. If you continue the habit

of drinking a quart of milk daily throughout life, this vitamin will likely be amply supplied.

Case Histories

1. *Mrs. M. H.* was a young woman, short and attractive, but inclined to be overweight. She consulted a dietician about a reducing diet. At the time, she complained particularly about her skin, which was always oily. Her nose and forehead were especially greasy in appearance. She had consulted many beauty shops and had followed the suggestions of the operators, without improvement.

   At this time little was known about the symptoms of a riboflavin deficiency alone. She had avoided milk, thinking it was fattening, and was eating almost no foods rich in the B complex for the same reason. She disliked liver.

   A reducing diet was planned which included a quart of skim milk daily. In addition, as a cheap low-calorie source of the B complex, she took a tablespoonful of powdered yeast, stirred into water, after each meal.

   To her surprise, within three weeks the oily appearance of her skin had completely disappeared. Apparently she had been suffering from a mild deficiency of riboflavin, which was overcome by the milk and yeast.

2. *Larry K.* went to work so early at the airplane factory that he let his young wife sleep while he prepared his own breakfast of bacon, eggs, coffee, and breakfast rolls or doughnuts. His lunch had been packed the night before and usually contained white-bread sandwiches, fruit, cake, and cookies. He ate it with hot coffee which he bought at the commissary. By dinner time, he wanted a man's meal of meat, potatoes, gravy, and a dessert which would stick to the ribs, together with several cups of coffee to help him revive from fatigue.

   Larry's eyes bothered him. They felt tired, were sensitive to light, and sometimes felt as if grains of sand were under the lids. Occasionally they were bloodshot. It never occurred to Larry that this condition had any connection with the fact that he drank no milk, ate no whole-grain bread, and had rarely tasted such

vegetables as chard, broccoli, kale, collards, or even turnip or beet greens.

A group of scientists who were studying the adequacy of the diet of American workers, examined the eyes of each person working in the plant for riboflavin deficiency. They found that a large per cent of the workers, including Larry, received inadequate amounts of this vitamin. Lists giving the riboflavin content of foods and the amounts needed were given out and the men were urged to improve their diets.

As soon as Larry substituted whole-grain breads and cereals for the refined products he had been eating, added vegetables to his diet, and drank milk daily, his eyes quickly improved.

Projects

1. Allow milk to sour; separate the curds and whey. What gives the green fluorescent color to the whey? Wash liver first to remove blood. Can you see the greenish color in water in which liver is soaked?
2. Compute the milligrams of riboflavin you have obtained through your diet, in the last twenty-four hours.

Topics for Discussion

1. Compare riboflavin with vitamin A in three or more ways; with thiamin.
2. What changes take place when riboflavin is inadequate? In what age group are riboflavin deficiencies most likely found? Why? Could deficiencies in vitamin A and riboflavin occur at the same time? What symptoms would likely show themselves? How could you recognize that both vitamins were lacking?
3. What are the advantages of the minimum daily requirement of riboflavin? Of four times that amount? Of eight times that amount?

Chapter 15

YOUR NEED OF NIACIN

The pellagra-preventing vitamin was never given an alphabetical name. Instead the name *niacin* or *niacin amide* is used. Formerly this vitamin was called *nicotinic acid,* or *nicotinic acid amide.*

Extent of pellagra. Pellagra has been the only vitamin-deficiency disease which has caused the death of thousands of people in the United States. In 1930, 6333 deaths were recorded from this cause, and the number was well over 800 even in 1946. Since only 3 per cent of the people who suffer from the disease die from it, Dr. Sebrell of the United States Public Health Department estimates that as many as 100,000 cases of pellagra occur each year in this country.

Symptoms of pellagra. Pellagra has often been spoken of as the disease of the three d's: diarrhea; dermatitis, or skin eruptions; dementia, or insanity. These, however, are symptoms of the disease in its most advanced stages. The skin, intestinal tract, and nervous system are not always simultaneously involved in each case, and there is no order of appearance of symptoms.

The skin is abnormal only in the more advanced stages and even then not always so. The parts of the skin likely to be exposed to the sun—hands, wrists, forearms, elbows, feet, ankles, legs, and knees—are red and scaly. The entire alimentary canal is sore from the mouth to the rectum. The tongue is often sore, and the inside of the mouth is a fiery red. As many as 60 per cent of the cases are found to have no hydrochloric acid in the stomach. Diarrhea is an early symptom and may be

extremely severe. Dyes added to the food of such patients have appeared in the feces within four hours, sometimes as soon as one hour after the food is eaten. This rapid transit of foods gives little or no time for digestion and absorption.

In the earlier stages the mental symptoms include: hostility, suspicion, violence, depression, and delusions. The patient frequently becomes disoriented. As the condition becomes more severe, it is characterized by hallucinations and often violent insanity.

The work of Dr. Goldberger. The knowledge that pellagra is a deficiency disease is largely due to the work of Dr. Goldberger of the United States Public Health Department. In traveling through the South he noticed that pellagra never occurred in homes where there were vegetable gardens and where cows and chickens were kept. In hospitals, he observed that the nurses and doctors given superior food did not contract the disease, although the patients frequently developed it. Final proof that pellagra was a deficiency disease was established when Dr. Goldberger arranged with the governor of one of the southern states to pardon a number of prisoners if they would eat foods such as were eaten by the poor people of the South. These men were given cornbread, fat pork, corn syrup, dried beans and peas, sweet potatoes, and yams in as large quantities as they cared to eat. In a few months pellagra developed and increased in severity. The disease was then cured by the addition of such foods as yeast and liver. It was thus definitely proved that the disease was caused by a dietary deficiency.

Niacin. Early in the study of vitamins a substance now known as niacin was found to occur consistently with thiamin. Niacin was tried in treating beriberi. As it was found to have no value, it was therefore discarded. Although niacin had been known as a drug for more than one hundred years, it had never been used in the treatment of pellagra.

Dr. Elvehjem and co-workers of the University of Wisconsin isolated niacin from liver. Since liver was known to be valuable in the treatment of pellagra, they fed this substance to dogs having the disease analogous to human pellagra. Remarkable cures were achieved. Immediately niacin was given to pellagrins, and the improvement was found to be equally prompt and dramatic.

When sufficiently large amounts of niacin are given to people suffering from pellagra, the mental symptoms frequently clear up within twelve hours. The confused patients become mentally alert; the maniacal ones, calm. There is rapid improvement of the sore mouth and tongue, and the abdominal pain and diarrhea are usually corrected within three days.

Pellagra as a public-health problem. Dr. Spies of the University of Cincinnati College of Medicine gave niacin to a group of nearly two hundred people who had either had slight symptoms of pellagra or recurring attacks each spring. Even though the diet was unchanged in other respects, pellagra was prevented.

By far the highest incidence of severe pellagra in the country occurs among the poor people of the South. These people are often share croppers who have no gardens of their own and no money with which to buy adequate amounts of fresh fruits, vegetables, and dairy products. Their diet is largely made up of fat salt pork, or sowbelly, sweet potatoes, cornbread, dried beans and peas, and corn syrup.

Pellagra is frequently encountered among alcoholic addicts who eat little food of any kind. It is sometimes seen among the well-to-do devotees of food faddism who have unwisely restricted their diets. Pellagra is not infrequent among people who, because of disease, must live on restricted diets or whose bodies do not absorb and use food efficiently.

The knowledge alone of how to prevent or cure pellagra,

though of tremendous importance, cannot stamp out the disease. The problem is economic and educational, rather than dietary. How can these thousands of people be taught the value of including fruits, vegetables, glandular meats, and dairy products in their diets? How can they be influenced to raise chickens, keep a cow, and tend a vegetable garden? The stamping out of pellagra is one of the major problems in public health which is by no means solved.

Mild lack of niacin. Dr. Spies and his associates, who have done outstanding work in the study of pellagra, stress that, preceding the disease, there is a change in personality. People who have been strong, courageous, forward looking, and unafraid of life become cowardly, apprehensive, suspicious, and confused. They are often depressed to the point where they feel it is impossible to carry on. They lack morale, that ability to keep going when the going is tough. These people do not have pellagra. They merely lack sufficient niacin to build positive health.

Dr. Spies lists the subtle symptoms occurring as the deficiency becomes somewhat more severe, but still preceding pellagra: insomnia, indigestion, abdominal pain, dizziness, headaches, nervousness, irritability, diarrhea, intense mental depression, and loss of appetite, weight, and strength. There is a decreased amount or absence of hydrochloric acid in the stomach. The entire group of symptoms would probably never be found in one person. Taking hundreds of patients as a whole, however, these symptoms would appear over and over.

The frequency with which these symptoms appear, and disappear when the vitamin is given, indicates a widespread lack of niacin.

Other uses of niacin. Many cases of diarrhea not associated with infections in the large intestines, or other known causes, have been very rapidly corrected when niacin is added to the

diet. In a number of studies, patients with various mental symptoms have been successfully treated with the pellagra-preventing vitamin, although no other evidence of pellagra existed even in the mildest form.

Skin conditions such as scaling of the hands and various types of rashes have often unexpectedly yielded to increased amounts of niacin.

The function of niacin. Many enzymes are unable to carry on their work without the presence of substances known as co-enzymes. Niacin goes to make up a part of two co-enzymes necessary before each cell in the body can burn food to produce energy.

Niacin is extremely important in keeping the tissues of the body healthy and normal. It must never be looked upon simply as a corrective for the deficiency disease, pellagra. If ideal health is to be obtained, this vitamin must be amply supplied in the diet at all times.

Sources of niacin. The amount of niacin contained in many foods has not yet been determined. Like other members of the B complex, liver and yeast are the two richest known sources. Fish, fowl, peanuts, dried beans and peas, and soybeans are all rich sources. Milk, buttermilk, and cheese contain only small amounts. Fruits and vegetables appear to lack niacin. A table giving the content of a few foods is shown on page 167.

Niacin is not harmed by long heating. It readily dissolves in water and is often lost in water in which foods are cooked unless the water is used in soups and gravies.

Like the other vitamins of the B complex, niacin is lost in refining. If the diet contains glandular meats, wheat germ, black molasses, and unrefined breads and cereals, together with milk and cheese, the niacin needs will be amply supplied.

Requirements of niacin. The exact amount of niacin needed to produce ideal health is not known. The amounts suggested

NIACIN CONTENT OF FOODS [1]
(After Elvehjem)

FOOD	MILLIGRAMS PER 100 GRAMS	FOOD	MILLIGRAMS PER 100 GRAMS
beef tongue	40–50	liver, veal	90
brain, beef	30–50	pork loin	45–60
ham	40	powdered skim milk	5–15
heart, beef	30	soybean flour	5
heart, pork	30	veal	50
kidney, pork	85–100	wheat germ	5–10
liver, lamb	120	yeast, bakers'	50
liver, pork	120	yeast, brewers'	100

[1] *What Are the Vitamins?* by Walter H. Eddy, Reinhold Publishing Corporation, New York, 1941.

by the Food and Nutrition Board of the National Research Council are listed on page 186. These requirements are minimum amounts which will prevent any appearance of pellagra. They are undoubtedly below the amount needed to produce full health, as shown by the fact that normal persons on an adequate diet excrete as much as 20 to 50 milligrams of niacin per day.

CASE HISTORY

Francis W. was eight years old. He was thin to the point of emaciation. Since early babyhood, he had suffered from certain food poisonings which caused his diet to be restricted. All dairy products had been avoided. For several months, he suffered from a diarrhea so severe that he was unable to attend school. His diet was still further restricted. He lived largely on toast made of white bread, refined cereals, mashed vegetables, and some soft cooked fruits.

The boy was nervous and irritable and cried easily. His disposition was such that it was impossible for him to get along with either his parents or his friends. His mouth was sore; his gums were puffy and inflamed.

His physician was puzzled for one certainly did not expect to find pellagra in a child, particularly a son of a wealthy family, and yet

his diet had lacked the vitamins of the B complex. All conceivable treatment aside from niacin seemed to have been already tried.

Liver, wheat germ, and tablets of the pure niacin amide were given the boy daily. The diarrhea cleared up in a surprisingly short time and never returned.

Projects

1. Find some person who has a personality characteristic of subtle niacin deficiency. Ask, if possible, what he has eaten in twenty-four hours. Could his diet be responsible for his dismal outlook on life?
2. Write down all the foods you have eaten in twenty-four hours. Estimate the milligrams of niacin you have eaten in one day. Is it as much as 50 milligrams?
3. If anyone in your family has the symptoms which precede pellagra, try to influence him to eat foods rich in the B complex and especially in niacin. If improvement is noticed, what conclusion is justified?

Topics for Discussion

1. What suggestions would you make toward stamping out pellagra in the southern states?
2. What is the first change which occurs when niacin is inadequately supplied? Could a lack of this vitamin in your diet be responsible for your occasional blues? Could the lack cause the difference between one person who is unafraid of life and another who is fearful?
3. Why is it especially valuable to supply abundant niacin in an army diet?
4. Is it more important to recognize subtle or advanced symptoms of a vitamin deficiency? Why?

Chapter 16

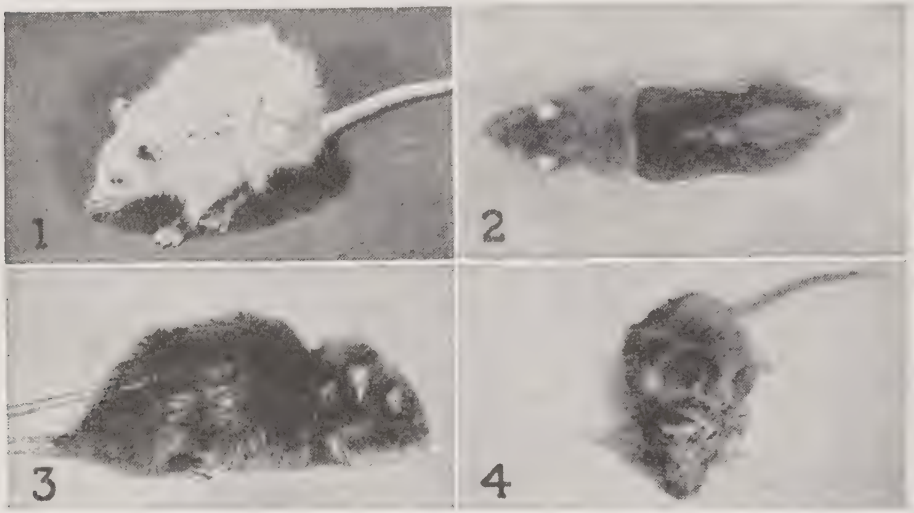
OTHER VITAMINS OF THE B COMPLEX

Several vitamins of the B complex have been isolated and made chemically more recently than thiamin, riboflavin, and niacin, and little is known of their individual functions in the body. Interesting evidence, however, is accumulating which indicates that the newer members of the vitamin-B family are probably as important as the older ones.

Pyridoxin. Like the other vitamins of the complex thus far studied, *pyridoxin,* formerly called *vitamin* B_6, serves as an enzyme in helping to break down food in the production of energy. Pyridoxin seems to be particularly concerned with the utilization of fats. It is probably necessary before fat can be formed from sugar. Animals lacking pyridoxin show a complete absence of storage fat, even though their diets have been high in calories.

Pyridoxin deficiencies in animals. When rats are kept on diets deficient in pyridoxin, growth ceases. They soon develop a severe skin condition, or dermatitis. The paws, ears, and nose are most affected and are red, swollen, and sore. The animals' muscle tone becomes poor as is shown by drooping shoulders, sway-backs, weakness, and a waddling or shuffling gait. As the deficiency becomes more extreme, nervousness, insomnia, irritability, and difficulty in walking are noticed. The heart muscles of such animals are damaged.

The pyridoxin potency of foods or medical preparations is tested by their effect on healing the skin condition and inducing growth in rats which have been kept on pyridoxin-deficient diets.



1. A pyridoxin deficiency results in a typical skin condition about the nose and paws.

2. The fur of this animal was entirely black before it was given a diet adequate in all respects except for pantothenic acid.

3. This is a para-amino-benzoic-acid-deficient rat. Note the eye involvement and the mild graying of the fur on the head.

4. An inositol deficient rat. Note loss of hair and marked eye involvement.

In dogs a lack of pyridoxin shows itself first in the development of a severe anemia. The amount of red coloring material in the blood, or hemoglobin, should ideally remain at 100 per cent. When pyridoxin was not supplied, hemoglobin was found to decrease at the rate of 10 per cent each week until it reached the alarming level of 10 per cent of its original value. When pyridoxin was put back in the diet, the color of the blood returned to 70 per cent of its original value in one week. This rapid increase indicates that pyridoxin is of great value in building and maintaining healthy blood.

Severe deficiencies of pyridoxin in several species of animals result in a tenseness and irritability of nerves and tissues. If the condition is prolonged, difficulty in walking is observed, which may become so severe as to develop into paralysis. In pigs, the

lack of pyridoxin causes convulsions similar to epilepsy.

Possible pyridoxin deficiency in people. A diet so unwisely chosen as to be lacking in one of the B-complex vitamins is also likely to be equally deficient in others. Dr. Spies and associates treated a number of patients for pellagra with niacin. Because of many evidences of deficiencies in thiamin and riboflavin, twenty-four of the patients were also treated with these vitamins. For the course of the study no improvement was made in diet. Despite the addition of the three vitamins, the patients complained of extreme nervousness, insomnia, irritability, abdominal pains, muscular weakness, and difficulty in walking. They were then given pyridoxin. Within a few hours all experienced dramatic relief of their symptoms. Their strength was greatly increased, and their nerves became calm. Within twenty-four hours all the symptoms had entirely disappeared. One patient who had been unable to walk more than a few steps walked two miles the same day the pyridoxin was given.

The dog above was maintained on a basal diet deficient in niacin. Below, is the same dog 10 days later, having received the basal diet together with the entire B complex.

This study shows beyond doubt that people require pyridoxin. Since these symptoms were so rapidly corrected by pyridoxin, it is assumed they were caused by a lack of this vitamin, and could have been prevented had it been supplied. It is probable that pyridoxin has to do particularly with the health of the nerves and muscular tissue.

Pyridoxin has also been used in the treatment of various types of muscular rigidity, stiffness of the legs, paralysis, and tremor of the hands so frequently seen in older persons. In these cases it has often given marked relief. These findings indicate that pyridoxin is one of tremendous importance.

The amount of pyridoxin which is required for full health is not known.

Food sources of pyridoxin. The most complete report to date of the food distribution of pyridoxin is given in the next paragraphs. The units used were defined as the amount of food necessary to correct the skin condition in rats produced when pyridoxin is lacking in the diet. Besides foods listed, yeast and black molasses are rich sources.

Like the other members of the B complex, pyridoxin dissolves in water. For this reason it seems strange that vegetable oils are the richest source of pyridoxin. The fact that pyridoxin is associated with oils, however, indicates that the vitamin is used by the plant as well as the animal in the formation of fat from carbohydrates. Pyridoxin is not harmed by oxygen or heat, and therefore is unaffected by cooking. It is readily lost in the water in which foods are cooked. It is undoubtedly wise to eat daily foods rich in this vitamin.

Pyridoxin content of foods. Recent laboratory experimentation has selected for us those foods which are rich in pyridoxin. Wheat-germ oil, which contains 25,000 units of pyridoxin per one hundred grams, is the most potent among the thirty-six foods so far tested. Corn oil tests second, with 20,000 units.

Egg yolk, lard, linseed oil, peanut oil, and rice oil each contain 2,500 units per one hundred grams; although only one eighth as potent as corn oil, these foods offer excellent sources of pyridoxin. Soybean oil varied from 1000–7500 units per one hundred grams. This variation in its potency was possibly due, in a large measure, to the soil conditions under which the soybean was cultivated. Peanuts, soybeans, wheat germ, and flaxseed were next in importance, as they tested between 1660 and 1000 units to one hundred grams. Alfalfa leaves, rice polishings, pork liver, navy beans, cornmeal, whole-wheat bread, dry yeast, and oatmeal were also found to be good sources of pyridoxin.

Pantothenic acid. A still younger member of the vitamin-B family is *pantothenic acid*. It apparently occurs in every living cell: in yeasts, molds, bacteria, and in the cells of all plants and animals. For this reason it was given the name of pantothenic acid from the Greek word, *pantos,* which means universal. It is apparently essential for the growth and normal function of every living cell.

Pantothenic acid occurs in human blood and in urine, and appears to be related to the action of riboflavin and pyridoxin.

Pantothenic-acid deficiency in animals. When black rats are given a diet which contains all the known vitamins of the B complex with the exception of the pantothenic acid, growth is retarded. In six to eight weeks the hair begins to change from black to gray; in a few more weeks skin eruptions occur. The animals take on all the appearance of old age: the skin becomes wrinkled, hair falls out, they become extremely thin and emaciated, and skin ulcers frequently appear. If pantothenic acid is added to the diet of deficient animals, the hair gradually changes to its natural color, and they again become healthy.

Sources of pantothenic acid. The richest source of pantothenic acid appears to be liver, yeast, and extract of rice polish.

Liver and kidney contain fifteen times more pantothenic acid than do muscle meats. Egg yolk, peanuts, soybeans, wheat germ, and dried beans and peas are good sources. Black molasses contains large amounts of riboflavin, pyridoxin, and pantothenic acid, but refined sugar contains none whatsoever. Whole grains and bran are good sources of pantothenic acid, but like the other vitamins, it is lost when grains are refined.

It appears that pantothenic acid occurs largely in foods eaten infrequently. What could be our most dependable supply has been discarded in the milling of grains and the refining of sugar.

Like thiamin, pantothenic acid is harmed by heat and oxidation and particularly by soda. It is readily lost in the water in which foods are cooked.

Para amino benzoic acid. A still younger member of the vitamin-B family is *para amino benzoic acid*. For some time at least one other vitamin in the B complex, now found to be para amino benzoic acid, has been known to play a part in the prevention of gray hair.

Dark mice become gray when their diet lacks this vitamin. Their fur changes back to dark in two weeks after the vitamin is again added to the diet. The same change has been observed in foxes, black dogs, and other dark animals.

Para amino benzoic acid appears to occur in liver, yeast, and rice polishing, more than in other sources of the B complex. Apparently, however, it is abundant in few foods.

Other vitamins of the B complex. Another vitamin of the B group is known as *inositol*. A typical experiment which threw light upon the value of this substance was carried out by Dr. Wooley of Rockefeller Institute. Mice were given a diet adequate in all respects except that it lacked inositol. Growth ceased and hair fell out until large areas of the bodies were nude. When either pure inositol or the natural vitamin

from liver or yeast was given, normal growth was resumed and a complete growth of new hair resulted in 18 days. Experiments on other animals show similar results

Inositol is especially rich in heart muscle, liver, and yeast, but occurs in many cereals such as oatmeal.

Many people who have added generous amounts of the entire B complex to their diets have reported noticing a rapid ingrowth of new hair. Since all the vitamins of the B complex so far investigated are needed by men in larger quantities than by women, it is possible that inadequate amounts of inositol may prove to be the reason men become bald whereas women rarely do.

Still another vitamin of the B family is known as *cholin*. This vitamin is especially important in transporting fats in the body. Without cholin, fat accumulates in the liver of both animals and people. As much as 40 per cent by weight of the liver may be fat. If the deficiency continues for a longer time, the liver is so damaged that it cannot function normally, and a disease known as *cirrhosis of the liver,* popularly called *fatty degeneration of the liver,* occurs. This condition may be prevented when cholin is included in the diet. Besides being found in the usual sources of the B complex, cholin is rich in egg yolk and brain.

Biotin is also a vitamin of the B complex. A substance in raw egg white, *avidin,* combines with biotin and prevents it from reaching the blood; hence biotin deficiencies are produced by feeding uncooked egg white. Dr. Sydenstricker and co-workers at the University of Georgia School of Medicine studied volunteers who lived on a diet low in biotin and containing raw egg white, but supplemented with minerals and other vitamins. The subjects developed dry, peeling skin, a marked grayish pallor to the skin and mucous membranes, muscle pain, lack of appetite, nausea, distress in the heart re-

gion, and mental depression which in some cases increased to mild panic. The symptoms were corrected in from 3 to 5 days when biotin was added to the diet.

The last vitamin of the B group to be made chemically is *folic acid*. This vitamin is essential before the body can produce normal red blood cells. When folic acid is undersupplied, the red blood cells do not develop normally, and fatigue, lassitude, pallor, and lack of energy result. Inadequate folic acid appears to be one of the causes of the disease known as pernicious anemia. The richest sources of folic acid are liver, yeast, and wheat germ. Smaller amounts are found in green leaves, or foliage, from which the name was taken. Of all the vitamins of the B group, folic acid is most easily destroyed by heat, although it is retained in quickly cooked liver. To obtain adequate amounts of this vitamin, raw foods such as green salads, uncooked wheat germ, and brewers' yeast should be eaten daily.

These lesser known vitamins of the B complex, pyridoxin, pantothenic acid, para amino benzoic acid, inositol, cholin, biotin, and folic acid, are certainly as important to health as are thiamin, riboflavin, and niacin. See that your daily diet contains ample amounts of all of them.

Case Histories

1. *Margaret M.,* an attractive girl of sixteen, consulted a physician about a muscular tremor of her hands. The shaking was so severe the she was unable to write or to take notes at school. She was extremely sensitive about the condition and would not eat in restaurants or go to the table when guests were entertained.

   Her diet was checked in every respect. She was asked to eat foods particularly rich in pyridoxin; to add 1 teaspoon of blackstrap molasses to each of four glasses of milk daily; to eat a half cup of

wheat germ daily; and to use corn oil in cooking and salad dressing. Besides these foods she took a heaping tablespoonful of powdered brewers' yeast in citrus juice after each meal. Within a month the tremor had disappeared to such an extent that it was no longer noticeable. More interesting still was the fact that her skin, which had been pimply and blotchy when she began the diet, became so satiny and lovely in texture that everyone remarked about it.

2. *Ellen B.* first noticed her hair becoming gray when she was twenty-five, and it contiuned to gray rapidly. She felt that it made her look years older than her friends; and feared that in a few years her hair would be white.

   One day Ellen happened to read in a magazine that two of the B vitamins together with the entire complex, had been given to people with gray hair and their hair had changed back to its natural color. She discussed this finding with her physician who planned a diet for her especially rich in the B complex and gave her a concentrate rich in pantothenic and para amino benzoic acids.

   Weeks passed and although Ellen noticed feeling unusually well, she could see little difference in her hair. Then after three months, her gray hair seemed to change to a dull, brownish gray. In another two months, the gray had almost disappeared.

   Ellen's only regret was that she had not known long before what foods were rich in these vitamins in order that she might have included generous amounts of them in her diet and prevented her years of worry and unhappiness.

Projects

1. Let each one in the class hold his hands before him. Do some students' hands quiver or shake, and others remain perfectly still? What might account for the difference?
2. Choose some older person whose hair shows little or no graying. Ask this person if he has always eaten foods rich in the B complex. Ask another person whose hair is prematurely gray the same question. Does one person appear to have had higher requirements of the B complex than the other?

3. List all foods you have eaten in twenty-four hours which contain vitamins of the B complex. Are any especially rich in pyridoxin or pantothenic acid?
4. Ask your mother to buy black, unrefined molasses. By eating only a little of it at first, develop a taste for it. The bitterness may be partly removed by the addition of a little salt or vanilla flavoring. When you have learned to like it, use it on cereals and wheat-germ hot cakes and waffles. Add it to milk. Ask your mother to use it in preparing such foods as cookies, gingerbread, and nutbread. What candy substitute may be made by using black molasses?

Topics for Discussion

1. Why should generous amounts of the vitamin-B complex be obtained if one wishes to have smooth healthy skin?
2. If a pyridoxin deficiency appears to exist, what oils might best be used for cooking?
3. Why should the vitamin-B complex be used rather than single B vitamins by a person who wishes to have: a strong heart; steady nerves; restful sleep; energy and endurance; and normal digestion? Why do separate deficiencies of different vitamins of the B group so frequently produce the same symptoms?
4. Of the vitamins of the B complex, which are unharmed by cooking? Which can be lost in cooking water? Why? Why cannot these vitamins be stored in the body?
5. Discuss ways of preparing liver and kidney so that they are delicious. If you do not enjoy these foods, what can you do to cultivate a taste for them?

Chapter 17

THE VITAMIN-B COMPLEX AS A WHOLE

When natural food sources supplying the entire vitamin-B complex have been used, instead of chemically made vitamins, better results have been consistently obtained in both animals and humans. This fact cannot be overemphasized since each year millions of dollars are spent on vitamin capsules and tablets. Such preparations usually supply small amounts of the cheaper vitamins which are made chemically, and entirely lack the vitamins not yet synthesized. The greatest harm resulting from the use of such vitamin capsules and tablets lies in the fact that many people take them, fully believing they are getting all the vitamins they need and in the quantities they should have. Nothing could be farther from the truth.

Reasons for the entire vitamin-B complex. There are two good reasons why all the vitamins of the B complex should be supplied:

1. Since these vitamins occur together in foods, no person can be deficient in one of the B vitamins without also being deficient in other vitamins of the complex. This fact remains true even though the deficiency of one vitamin appears to be more prominent than that of any other vitamin of the group.

2. The efficient action of any one vitamin of the complex depends upon the presence of the other members of the group. In other words, the functions of all are interrelated. For example, it first appeared that if niacin were added to all salt sold in the southern states, the pellagra problem could be quickly solved. This supposition was soon disproved by the knowledge

that no one vitamin of the B complex can do its work without all the other vitamins being supplied or present.

Reasons for using natural sources. Natural sources of the vitamin-B complex, such as liver and yeast, appear to contain all the vitamins of the group both known and unknown. Not all of these have been made chemically. There is much evidence that several others exist. These vitamins which have not been made chemically can come only from natural foods.

Dr. Wilbur of Stanford University has pointed out that it is as illogical to treat a deficiency of any of the B vitamins with one vitamin alone, as it is to treat a protein deficiency with a single amino acid. It is equally as illogical to try to prevent a vitamin-B-complex deficiency by taking tablets which supply one or two vitamins of the group. Single vitamins can be obtained only from the drug store. Full health is built only from natural foods which must come from the garden and grocery.

Vitamin-B complex and infections. No single vitamin of the B complex alone appears to build resistance to infection. In experiments carried out at the University of Toronto, however, one group of rats was given a diet only slightly deficient in the vitamins of the B complex. Another group was fed the identical diet except that generous amounts of these B vitamins were supplied. In both groups, growth was normal, and the animals appeared to be healthy. But, when all of the animals were fed disease-producing bacteria, only 20 per cent of the group which was somewhat deficient in the B vitamins survived, contrasted with 87 per cent of the group which had been fed these vitamins in more generous amounts.

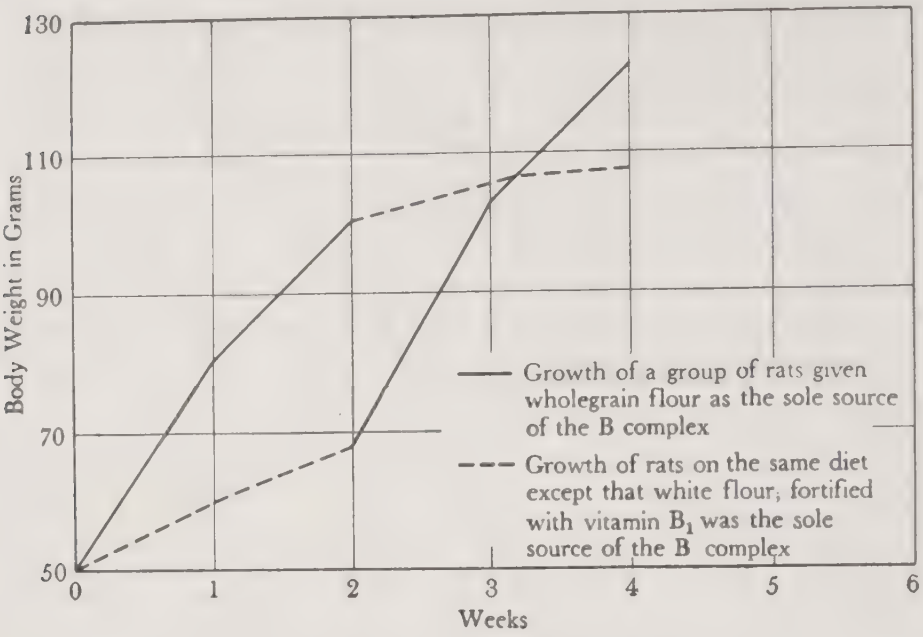
People suffering from deficiencies of the B complex have low resistance to infections. Yet, how these vitamins aid the body in building natural resistance is not known.

B-complex deficiencies and the death rate. Since the milling of grains began, certain diseases have increased noticeably. This is particularly true of three which are now the leading causes of death: heart disease, kidney disease, and cancer. One out of every six persons over forty dies of heart disease; one out of every six dies of kidney disease; one out of every five and one half dies of cancer. Moreover, during the last ten years, high blood pressure had increased 250 per cent. It has been pointed out by Dr. Haven Emerson of Columbia University that since grains were first milled, diabetes has increased 1150 per cent. Anemia and appendicitis have likewise increased at an appalling rate.

It must not be implied that the entire reason for such increases in disease is the milling of grains. Yet, it has been repeatedly stressed by numerous investigators that these diseases are unknown among primitive races who use only unmilled grains which are rich in the vitamins of the B complex. Even in our own country, groups of people, notably the Latter-day Saints, who have adhered to sound principles of nutrition, have far fewer deaths from the above-mentioned diseases than a similar number of the population as a whole.

An increase in the vitamins of the B complex has been shown to result in a decrease in death rate. For example, during World War I, food shortages caused the government of Denmark to forbid the milling of grains. This improvement in nutrition caused the death rate to drop 34 per cent; the amount of sickness also greatly decreased. Similar results have occurred in other countries where, for the sake of economy, no grains were allowed to be milled.

Fortified breads. At the beginning of the second World War the National Research Council realized that almost every person in America was deficient in the vitamins of the B complex,



Notice that the diets were reversed after two weeks.

and that these deficiencies could be largely eradicated overnight if only unmilled breads and cereals were used. Though for twenty years there have been attempts to educate the public to eat whole-grain breads, in 1940 only 2 per cent of all grain foodstuffs sold for human consumption were unmilled. Yet the public was fully aware that the vitamins and minerals were lost in the milling process.

Since people cannot be forced to build health, and the majority consider the taste of food of greater importance than their health, the government urged the fortification of all white flour. The millers were asked to add iron, thiamin, riboflavin, and niacin to flour in the amounts in which these occur naturally in unrefined grain. It must be distinctly understood that far more minerals and vitamins are lost in refining than these four substances and that no one has wished to imply that fortified white bread can compare with whole-grain bread. Fortification is merely a temporary step until popular

education can convince the people that building health is worthwhile.

When different groups of rats are given whole-grain bread, fortified white bread, and ordinary white bread, the animals receiving whole-grain bread grow almost twice as large and are much more healthy than those given fortified bread. The animals receiving fortified bread are, however, superior to the refined-bread group.

Your choice of breads and your intelligence. An analysis of the food consumption of more than 250 families revealed that whole-grain breads were used at least part of the time to the following extent: by all the professional families; by about half of the shopkeepers; by less than 40 per cent of the skilled workers; by only 14 per cent of the unskilled workers and the unemployed. The study showed that the amount of whole-grain bread used was an index of intelligence and social standing. Many breads contain some unrefined flour, but they are not 100 per cent whole grain. These are usually labeled wheat breads. The label, as well as the appearance, mislead the public into believing that they are getting the whole-grain product when they are not. Always look for the *100 per cent whole grain* mark on the label.

How can a person knowingly select a bread which cannot build health, in preference to one for the same price which can build health? The intelligent person plans, guards, and builds his health day after day.

Variations in body requirements of the B complex. More is known concerning the body's requirements of thiamin than of other vitamins of the complex. It appears, however, that any influence which increases the need for this vitamin also increases the need for others of the group. For this reason, variations in the thiamin requirements are used as an index of the needs for the entire complex.

The more carbohydrate food eaten, the larger must be the intake of thiamin, because this vitamin and several others of the group are used in burning sugar to produce energy.

The more energy spent, the greater amount of thiamin needed. Almost all of the vitamins of the complex are used in energy production. The athlete needs much more vitamin-B complex than the bookworm does; the nervous, high-strung person more than the calm, lethargic one.

Thiamin is also needed in proportion to the amount of muscle tissue in the body, because the muscle cells produce the largest amount of energy. As a rule, men have more muscle than women have; hence men, as a group, need more vitamin-B complex than women do.

Requirements during growth. The child who is growing rapidly needs relatively larger amounts of vitamin-B complex than an older person. In addition to the demands of growth, he is usually more active than an adult.

The need is particularly high in boys between the ages of fifteen and twenty years. A 1938 report from St. Luke's Hospital at Shanghai, where 60 per cent of the admissions suffered from beriberi, states that acute, sudden heart failure causing death was greatest in boys of this age. The boy between fifteen and twenty often has many pounds of muscle weight. He is extremely active, eats large amounts of carbohydrate, and may still be growing rapidly. Each of these conditions increases his need for the vitamin-B complex, and all combined skyrocket his requirements until his intake must be especially abundant if he is to remain in buoyant health. His requirements are far too high to be left casually to chance. If he wishes to have vitality, he must plan his nutrition.

A partial lack of the vitamins of the B complex, like that of any other body requirement, can cause a stunting of growth. Since this group of vitamins is so meagerly supplied in the

American diet, and since boys need larger amounts of these vitamins than do girls, mild deficiencies of the B vitamins are probably limiting the growth of many boys. Recently a group of people watched perhaps two hundred high-school boys and girls dancing. One person remarked, "Almost every girl here seems healthy, but it's difficult to find one tall, well-developed boy." It was true. Teachers frequently point out that the same difference is most noticeable at high-school commencements. The girls are well developed; the boys are not. No other body requirement is needed by boys in so much larger amounts than by girls, as is the B complex.

Requirements of the athlete. The high-school athlete who is still growing probably has a higher requirement of the vitamin-B complex than any other person. The boy who eats foods which meet his requirements soon finds that he tires less easily, has more endurance, and enjoys his athletics to a greater extent than when his diet is unplanned.

Much harm is continually being done by coaches who allow boys to undergo unusual physical strain without first making sure that the increased requirements of the vitamin-B complex are met. Enlarged, damaged hearts, which could easily be prevented, are almost the rule in certain types of athletics. Abnormalities of the nervous system are not uncommon and appear to be rapidly increasing.

Requirements during illnesses. The need for the vitamins of the B complex appears to be greatly increased by almost all infections and diseases. Bacteria require B vitamins for growth; hence during an infection or infectious disease, the bacteria steal the available supply of B vitamins and cause deficiencies to develop even when the diet is adequate. The burning of sugar to produce fever greatly increases the need for the B vitamins. Digestive disturbances and diarrhea interfere with the absorption of foods to such an extent that few

vitamins may reach the blood. The ill person usually lacks appetite, and food for him is frequently so carelessly planned that the intake of B vitamins is greatly decreased at the very time these vitamins are most needed.

Requirements of the B vitamins. The Food and Nutrition Board of the National Research Council have recommended daily allowances of the better known B vitamins. These allowances are given in the following table. The Board emphasizes

	THIAMIN, MILLIGRAMS	RIBOFLAVIN, MILLIGRAMS	NIACIN, MILLIGRAMS
Man (154 pounds)			
Moderately active	1.8	2.7	18
Very active	2.3	3.3	23
Sedentary	1.5	2.2	15
Woman (123.2 pounds)			
Moderately active	1.5	2.2	15
Very active	1.8	2.7	18
Sedentary	1.2	1.8	12
Children (up to 12 years)			
Under 1 year	0.4	0.6	4
1–3 years	0.6	0.9	6
4–6 years	0.8	1.2	8
7–9 years	1.0	1.5	10
10–12 years	1.2	1.8	12
Children (over 12 years)			
Girls, 13–15 years	1.4	2.0	14
16–20 years	1.2	1.8	12
Boys, 12–15 years	1.6	2.4	16
16–20 years	2.0	3.0	20

that these are maintenance requirements designed only for healthy people, and that much larger amounts are needed when deficiencies already exist. Since the B vitamins occur together, if these recommendations are met entirely with natural foods it is assumed that adequate amounts of all the B vitamins will be supplied.

Two questions arise: 1. Where can a completely healthy person be found? and 2. Who wishes to be satisfied with maintenance requirements? Experiments with people have shown that when these amounts are double and later tripled,

there results each time a greater feeling of well being and zest for life. The larger amounts undoubtedly approximate those needed to produce full health, and should be set as a goal to strive for. If you desire the best health possible but are not especially active, multiply the figures in the table by two, and try to get these quantities of vitamins in your daily diet. If you are especially active, if you play tennis or football or dance a great deal, multiply the amounts by three to arrive at your daily requirement. If you recognize signs of deficiencies of the B vitamins in yourself, such as being less energetic than you desire, feeling mentally depressed at times, or having visual difficulties when studying, multiply the amounts by four. If you obtain these amounts of B vitamins daily, you will probably be amazed to find how much better you feel.

All the B vitamins dissolve in water so readily that if more are eaten than are needed, the excess is quickly lost in the urine. For this reason even very large amounts obtained from natural foods are not toxic. It therefore seems wise to err by taking too many rather than too few.

Losses of the vitamins of the B complex. Since all the B vitamins quickly dissolve in water, great losses occur when foods are soaked or boiled and the water is discarded. Soaking should be strictly avoided. Vegetables should be steamed, sauteed, baked, or cooked by any waterless method.

Riboflavin is destroyed by light, particularly during cooking. Milk should not be left on a doorstep. Foods should be stored in the dark. They should be covered during cooking, and glass cooking utensils should be avoided.

Thiamin, niacin, and all the B vitamins which are acids are harmed when soda is used in cooking. Soda should not be added to vegetables to retain their color. Baking should be done with baking powder or yeast instead of soda.

Of the entire B complex, only thiamin and folic acid are harmed by heat. Folic acid is destroyed so quickly that uncooked foods such as green salads, raw wheat germ, and brewers' yeast should be used as reliable sources. Thiamin is not destroyed unless foods are cooked under pressure for an hour or longer.

Meeting your vitamin-B-complex needs. Since the B vitamins dissolve in water, which is not stored in the body, these vitamins cannot be stored. If full health is to be maintained, the daily diet must furnish them.

To supply your needs, buy only breads and cereals with 100 per cent whole grain marked on the labels. Use wheat-germ breads, pumpernickel, and black Russian rye whenever possible. If wheat germ is not sold in your locality, ask your grocer to order it from the nearest flour mill.

Wheat germ may be cooked five minutes as a cereal, added to any quick-cooling cereal, or mixed with prepared cereals and eaten uncooked. Eat only a little at first if you do not like the taste, and gradually increase the amount as you learn to enjoy it. By the use of wheat germ instead of half the flour in any good recipe, delicious waffles, hot cakes, muffins, biscuits, pie dough, yeast breads, nutbreads, cookies, and almost any other breadstuffs can be prepared. Wheat germ can also be used instead of cracker crumbs and added to such foods as meat loaf. It should be kept in every household and used daily.

Blackstrap molasses is an excellent source of all the vitamins of the B complex except thiamin and folic acid. This molasses is a by-product of the cane-sugar industry. It is now largely used for fattening cattle and may be purchased inexpensively from molasses companies. Cane juice contains vitamins and minerals necessary for the life of the plant just as does any fruit or vegetables juice. In making sugar, the cane juice is boiled down until some 30 gallons of juice is concentrated into

1 gallon of molasses; therefore the nutrients not harmed by heat are concentrated to thirty times that of the original juice. At this stage, the molasses is dark (much like that sold in groceries for making gingerbread and spice cookies). Sugar, a pure substance devoid of vitamins and minerals, is then crystallized out of the molasses and removed. For every ton of sugar made, there remains about 30 gallons of blackstrap molasses which contains the entire amount of minerals and heat-stable vitamins of the original juice. Blackstrap, therefore, is extremely rich in nutrients because they are concentrated both by boiling and by the removal of sugar. Thiamin and folic acid, the only vitamins harmed by heat, are destroyed during the boiling process. Thiamin can be replaced by dissolving a few tablets of synthetic thiamin in a little water and stirring them into the molasses. By replacing the thiamin, a concentrate extremely rich in minerals and all of the B vitamins, except folic acid, may be had at a very low price.

Blackstrap may be taken directly from a spoon, stirred into milk, or eaten on bread, hotcakes, or waffles. If you have never tasted it, expect to dislike it. Take no more than a half teaspoonful at first, but eat this amount daily. In this way you will cultivate a taste for it and, in about two weeks, in all probability you will consider it delicious.

Whole-wheat macaroni, spaghetti, and noodles may be purchased and should be used to the exclusion of the refined varieties. Brown rice should replace white. Get acquainted with whole buckwheat, and steam it twelve minutes by putting it on to cook in twice as much water as grain. It makes an excellent hot cereal or may be served as a vegetable. Use soybeans, baked or in a loaf or patties, as meat substitutes.

If you have not done so already, cultivate a taste for liver, brain, kidney, heart, and sweetbreads and use them more frequently than other types of meat.

Salted peanuts and roasted soybeans are ideal candy substitutes which build rather than destroy health. Both are excellent sources of the vitamins of the B complex. Yeasted peanut butter is sold on the market. It tastes no different from the usual variety and should be used by everyone.

The healthiest people have the most fun.

Brewers' yeast is a by-product of all breweries, and in the majority of cases, is still thrown into the sewer. Only popular demand can stop this needless waste of one of the best sources of the B complex. This yeast dried into a powder may be purchased inexpensively from health food stores or yeast companies. A heaping tablespoonful contains 3 or 4 milligrams of thiamin, and an equally large proportion of all the vitamins of the B complex. Its concentration of B vitamins and of adequate protein has caused yeast to be called a "miracle food."

It is quite palatable when a heaping tablespoonful is stirred into a glass of milk or grapefruit juice. If every person in our country would take a tablespoonful of brewers' yeast daily, the increase in health would be almost unbelievable.

On the other hand, fresh bakers' yeast, such as that used in making bread, is extremely dangerous to eat until it is cooked. Live yeast grows in the intestines. It not only keeps the B vitamins it contains, but uses the B vitamins supplied by the food eaten, leaving none to enter the blood. Experiments have shown that the quickest way to produce deficiencies of B vitamins in humans is to have them eat a cake of fresh bakers' yeast daily. The more yeast eaten, the more severe are the resulting deficiencies of B vitamins.

Need for careful planning. Of all the body requirements, the B vitamins are the most difficult to obtain from our American diet. Before the refining of flour, whole-grain breads and cereals were reliable sources. Formerly, these foods were eaten in much larger quantities than they are now. Foods especially rich in these vitamins are often disliked, as liver, or little used, as wheat germ, or even unknown as foods, as brewers' yeast and blackstrap molasses. Except for persons trained in nutrition, it is difficult to find anyone who does not suffer to a certain extent from deficiencies of the B vitamins. It is up to you to see that foods furnishing these vitamins are served daily in your home if you and your family are to remain healthy.

Many people who have a smattering of knowledge of nutrition take so-called vitamin-B-complex capsules, thinking they supply all the B vitamins needed. At the present writing (1948) such capsules usually supply the minimum daily requirements of thiamin, riboflavin, niacin, and pantothenic acid, and an extremely small amount of pyridoxin. The equally important B vitamins, biotin, folic acid, para amino benzoic

acid, cholin, and inositol, are not supplied. Research indicates that there are still more B vitamins not yet isolated. The only way to obtain all of the vitamins of the B group is from natural foods.

The quick pick-up diet. For persons suffering from deficiencies of the B vitamins or for anyone whose requirements are temporarily high—perhaps a boy playing in a basket ball tournament or someone who must work several hours after school—the following foods might be had daily for a week or more.

	MILLIGRAMS OF			GRAMS OF PROTEIN
	thiamin	riboflavin	niacin*	
yeast, 4 heaping tablespoons	14.0	5.0	100	48
fresh milk, 1 quart	0.3	1.9	—	32
powdered milk, ½ cup	0.3	1.6	—	34
wheat germ, ½ cup	2.6	0.7	10	24
liver, beef, 1 serving	0.3	2.5	34	20
total	17.5	11.7	144	158

* See table, page 167.

A palatable "malt" can be prepared by beating the yeast and powdered milk into a pint of fresh milk, sweetened as desired with blackstrap molasses; after the mixture is smooth the remaining pint of fresh milk can be added. This "malt" can be drunk with meals and between meals. The wheat germ could be eaten raw or cooked as a breakfast cereal. Liver might be had at dinner. If you wish to reduce, wheat germ could be omitted, the liver broiled, and the "malt" prepared with skimmed fresh and powdered milk. Almost every person, regardless of how healthy he considers himself, would feel better if he took this "malt" as a supplement to his daily diet.

Whatever be your sources of the vitamins of the B complex, they must be generously used day after day if you are to achieve full health. Unless drastic changes are made in the American diet, these vitamins will not be amply supplied without effort, forethought, and careful planning. Err on the side of getting too many rather than too few.

Case Histories

1. *Elmer B.* was halfback on a certain high-school team. His coach was interested in nutrition and asked the boys to eat a half cup of wheat germ daily. At first Elmer disliked it, but he felt he could eat it if the other boys did. He soon noticed that he had more endurance, that he was less fatigued after practice and the games, and that his wind was better. He often remarked that if he went off his diet for even two days, he could notice the difference. Elmer reported that at every game the coach would ask them to make a touchdown for wheat germ, and they made it. Every team in the country, whether playing football or any other game, should be making touchdowns for wheat germ.
2. *Ruth O.* was having some of her high-school friends in for Sunday night supper a few days after the B vitamins had been studied in science class. What could be better for supper than yeast waffles made with wheat germ?

   Late Sunday morning Ruth carefully mixed the batter: 2 cups of milk heated to lukewarm into which she crumbled a cake of fresh, bakers' yeast; she added 2 tablespoonfuls of blackstrap molasses, ⅓ cup of vegetable oil, 1 cup of wheat germ, and sifted in 1¼ cups of whole-wheat flour, 1 teaspoonful salt, and ½ cup powdered milk. She stirred the batter thoroughly and set it aside in a warm place to rise. Each time it doubled in bulk, she stirred it again. Just before time for her guests to arrive she divided two eggs, dropped the yolks into the batter, which she stirred well, and beat the whites stiff and folded them in.

   As the waffles baked, the yeast smelled delicious. Ruth served the first round of waffles with creamed chicken to which new peas and pimientos had been added, and the remaining waffles

with hot butter and syrup. Her guests agreed that there was something wrong with the theory that foods which built health had to taste "bad."

Projects

1. Influence your family to buy only 100 per cent whole-grain, soybean, and wheat-germ breads. If these are not carried in your locality, ask for them every time you go to the bakery or grocery. If for any reason some member of your family must eat bread free from cellulose, see that the white bread purchased is fortified with iron, thiamin, riboflavin, and niacin.
2. Start a campaign to have the school cafeteria carry only whole-grain and wheat-germ breads and cookies made of wheat germ, black molasses, nuts, and fruits. Write a series of articles for the school paper, telling how your cafeteria helps the students build greater health. Give clear reasons for your contention.
3. Whenever you eat in restaurants, always ask for 100 per cent whole-grain breads and get your acquaintances to do the same. All restaurants will serve these superior products as soon as the public demands them. In this way you will help build up the health of many people.
4. Send a committee to a drug store to investigate vitamin capsules and tablets. Record the prices and the amounts of each vitamin supplied in the products. How many of the preparations contain all the vitamins of the B complex? What are the prices compared with equal amounts of the vitamins obtained from a half-cup of wheat germ or one heaping tablespoonful of powdered yeast?
5. If possible, bring waffle irons from home and prepare wheat-germ waffles in class. If cooking is not possible, have students bring from home samples of wheat-germ cookies, muffins, gingerbread, nutbread, yeast biscuits, and other foods prepared from wheat germ. See footnote, page 66.
6. Compute the amounts of thiamin and riboflavin you have eaten during the last twenty-four hours. How does your intake compare with the suggested daily requirements of each for your weight?
7. Since the vitamins of the B complex are so meagerly supplied in the American diet, plan a series of talks by different members

of the class to be given before the Parent-Teachers Association or similar organizations. Separate talks might be given on each vitamin of the complex, one on the complex as a whole, one on fortified breads, one on the best sources of these vitamins. What other means can you use to influence people to increase their intake of these vitamins?

8. Calculate the number of 10-milligram tablets of thiamin which would need to be added to 1 pint of blackstrap so that each tablespoonful would contain 2 milligrams of thiamin. How much would this amount of thiamin cost?
9. Have everyone in the class who is willing live on the "quick pick-up" diet for one week. How many notice an improvement in health?

Topics for Discussion

1. Give a detailed answer to the often-repeated question, "Why are vitamins and minerals taken out of the bread and then put back again?"
2. Why do boys need more vitamins of the B complex than do girls? Which girls in your class need more of these vitamins than other girls do? Why do more men than women die of heart disease? Would more of these vitamins be needed in hot weather than in cold?
3. What sources of the vitamin-B complex would you suggest for a person who is ill? Why is the need for these vitamins increased during illness? Check standard books which give diets for ill persons, and determine the amounts of thiamin and riboflavin, as index of the complex, likely to be eaten in one day. Why cannot the vitamins in fortified bread be used as an index of the complex?
4. Discuss the statement: "Your requirements of the B vitamins are as varied as your activities." Make a list of your activities and state when your intake of these vitamins should be increased.

Chapter 18

ASCORBIC ACID AND SCURVY

All fresh, growing foods contain *ascorbic acid,* formerly called *vitamin C.* Our richest sources are citrus and tomato juice, cabbages and green peppers. Whenever people have been unable to get fresh foods, the ascorbic-acid-deficiency disease, known as *scurvy,* has resulted. It has probably existed since men first lived on the earth. No account of ascorbic acid would be complete without mentioning the fascinating and tragic role scurvy has played in the history of nations.

The history of scurvy. Hippocrates (460 B.C.) wrote of the disease now recognized as scurvy. He described how large numbers of men in the army suffered from pains in the legs, gangrene of the gums, and loss of teeth.

Records dating back to the crusades (twelfth to the fourteenth centuries) tell of the ravages of scurvy among the men, causing hundreds to die. It was especially severe during Lent, when the men often gave up the few available foods which might have contained ascorbic acid.

Many reports dating from the fourteenth century on tell of the epidemics of scurvy in northern Europe during the long winters, when no fresh foods were to be had. The early French-Canadian settlers are said to have lost so many of their members from scurvy during the severe winters that they considered abandoning their settlements. In Newfoundland, the English suffered intensely from scurvy and were forced to give up their plans for colonizing the Hudson's Bay region. The disease was not unknown among those who came over in the *Mayflower.*

Scurvy seems to have been ever present among armies in all parts of the world. It has played a role in all wars from the campaigns of Caesar down to the present time. The army records show that 30,714 cases occurred during our Civil War. Hundreds of thousands of cases were reported among troops of all nations in World War I.

Even in the summer, scurvy has been a constant occurrence in besieged cities when foods from the surrounding country could not be brought in. During the siege of Paris in the Franco-Prussian War of 1870–1871, when the inhabitants were forced to live largely on rice and bread, almost no one escaped suffering from scurvy. Even the hospital patients who were allowed potatoes and horse meat developed the disease. A severe outbreak occurred in 1937, during the Spanish Civil War, particularly at the time of the siege of Madrid. In prisons, insane asylums, orphanages, and institutions for the poor, scurvy has often been as severe as in the armies. There are 143 land epidemics of scurvy recorded between 1556–1877.

Scurvy has also been associated with crop failures throughout the world. India has been conspicuous for its large number of epidemics due to this cause. In Ireland, the potato, low in ascorbic acid but eaten in such quantities that it becomes a significant source, has usually prevented scurvy; failures in the potato crop repeatedly brought on epidemics.

Wherever it is difficult to produce natural food supplies, scurvy has appeared and often has determined the future course of events. It has caused untold misery and brought about a tremendous waste of life and health.

Scurvy at sea. The early voyages of exploration focused attention on scurvy and eventually led to the knowledge of its cure and prevention. During long trips on sailing vessels there were often many months when little or no fresh vegetable or animal food was obtainable. The result was inevitable. Three

or four months after the ships were out of touch with land, the majority of the crew were incapacitated by scurvy. Many expeditions were wrecked because of it.

Lord Anson, in 1740, after losing four out of five of the original members of his crew from scurvy, finally gave up his expedition to South America because of the disease. The records of the voyages of Vasco da Gama, Magellan, Drake, and many others contain accounts of the ravages of scurvy.

Cartier, who in 1536 set out to explore the St. Lawrence, arrived with his entire crew sick and twenty-six men already dead from scurvy. Several of his men, hopelessly ill, were set ashore to die. A few days later the captain, going ashore, found these same men miraculously cured. The Indians had given them a tea made of growing spruce needles.

Other accounts exist in which men, put ashore to die and unable to walk, ate grass. Within a few days they were well again. One sea captain carried a cargo of onions, which sprouted during the trip. The crew ate the sprouts, rich in ascorbic acid, and the existing scurvy was cured. The treatment seemed so successful that on subsequent voyages this same captain generously fed onions to the crew with varying results. Unless the onions had sprouted, they failed to prevent scurvy.

Time and again certain foods seemed to prevent scurvy, but since ascorbic acid occurs only in growing plants, the same foods in a matured state failed to prevent the disease. The disease, however, was generally attributed to the eating of too much salty meat, to ocean breezes, or to damp air. The extent to which scurvy occurred is shown by the fact that, until the time when preventive measures were taken, it was estimated that the disease destroyed more sailors than all other causes incidental to sea life, including all naval battles.

In striking contrast to other early voyagers, Captain James

Cook in 1768 undertook a three-year trip encircling the globe and returned without one death from scurvy or even a severe occurrence of the disease. This remarkable feat was accomplished by serving a drink made of sprouted barley, which was prepared fresh almost daily and served liberally. The captain cleverly gave this drink only to his officers at first until the crew decided that it must be something choice and demanded it also. Captain Cook's voyages centered attention on the possibility of preventing scurvy and resulted in better food supplies for the navy.

As early as 1600 a crew of a British ship, going from England to India, had remained free from scurvy by the use of lemon juice. This juice was used successfully from time to time, and in 1804 it became compulsory for each sailor in the British navy to have a daily ration of lemon juice. At that time lemons were called *limes,* and from this practice came the nickname, *limey,* for British sailors.

Prevention of scurvy. A modern method of treatment and prevention was carried out by the British colonial troops fighting in Mesopotamia during World War I. In the summer of 1916 there were more than 11,000 cases of scurvy, and 7500 men died from the disease in less than four months. Gardeners' corps were formed, seed packets were distributed to various army units, and gardens were planted over the surrounding country. At Bagdad alone more than 400,000 pounds of fresh vegetables were produced, with the result that the amount of scurvy in this section was greatly reduced in 1917 and almost disappeared by 1918.

Scurvy in infants. After the advent of the artificial feeding of babies, infantile scurvy became a serious problem particularly because the work of Pasteur emphasized the boiling of milk. The disease was often advanced by the time the baby

was three months old, and in many cases caused death a month or two later. Scurvy in infants is now almost universally prevented by the feeding of citrus juices.

Symptoms of scurvy. Spongy and bleeding gums, loose and falling teeth, have been ever-present symptoms of scurvy. The only exceptions are in babies where the teeth have not erupted and in older persons who have already lost their teeth. The joints become tender and swollen. Hemorrhages under the skin cause black-and-blue spots to appear, especially in the parts of the body most used or pressed by clothing. The bones lose much of their calcium and often break. Though actual scurvy is rarely seen today, these same symptoms in milder form are not uncommon and are known to be caused by an undersupply of ascorbic acid.

Scurvy responds rapidly to the simple addition of fresh fruits and vegetables to the diet. It can easily be prevented by fresh foods on the daily menus.

Project

1. Have each member of the class look up some historical reference to scurvy.

Topic for Discussion

1. What are the symptoms of scurvy? Since the disease rarely occurs now, what value can there be in studying its symptoms? What is the principal difference between a partial and an almost complete ascorbic-acid deficiency? What symptoms of scurvy have you observed in yourself or other people?

Chapter 19

THE NEED FOR ASCORBIC ACID

Scurvy is not entirely a disease of the past. Alcoholic addicts who eat little food of any kind sometimes develop the disease. In fact, the alcoholic addict so frequently presents a picture of all the deficiency diseases that he is now being used to study the changes in the body when certain vitamins are lacking. Ironically enough, such derelicts of humanity are making a definite contribution to scientific knowledge.

Even though scurvy is rarely seen today, mild deficiencies of ascorbic acid are widespread. These cause much distress and preventable suffering. A knowledge of the changes due to lack of ascorbic acid can help the student to plan his health wisely.

Experimental scurvy. In 1907, two Norwegian scientists attempted to produce beriberi in guinea pigs by feeding them polished rice and water. Instead, the animals developed scurvy. Before that time unsuccessful attempts had been made to produce scurvy in the dog, goat, and other animals. It is now known that only guinea pigs, members of the monkey family, and humans must depend on foods to supply ascorbic acid. All other animals can make, or synthesize, their own supply.

Since monkeys are expensive and difficult to work with, the guinea pig has become the standard experimental animal for the study of ascorbic acid deficiencies.

Young guinea pigs, six to eight weeks old, are put on an ascorbic acid-deficient diet of oats, wheat bran, butter fat, salt,

and powdered skim milk heated until the small amount of ascorbic acid it contains is destroyed. In addition, those animals which are to be kept free from scurvy are given some form of ascorbic acid, usually citrus juice. The negative controls are given no ascorbic acid. Other guinea pigs receive varying known amounts of foods to be tested. If the animal is protected against scurvy, the food is shown to contain ascorbic acid. The international or U.S.P. unit is defined as the amount of ascorbic acid which, when fed daily to a standard guinea pig, just protects it against scurvy.

The separation of ascorbic acid. In 1932, Dr. King and coworkers at the University of Pittsburgh separated from lemon juice a crystalline substance which in minute quantities protected guinea pigs from scurvy.

Earlier Dr. Szent-Gyorgyi, working at Cambridge University, England, had isolated white crystals from cabbage, oranges, fresh paprika, and adrenal glands. He lost interest in the crystals and set them aside for four years. Stimulated by the work of Dr. King, he made intensive studies of the crystals and found them to be pure ascorbic acid. He found that ascorbic acid is necessary for the normal function of all cells in the burning of foodstuffs. For his work he received the Nobel prize in medicine for 1937.

In 1933 pure ascorbic acid was made chemically in the laboratory. One milligram of this substance is equivalent to twenty units. If you wish to change milligrams to units, therefore, multiply by twenty.

Functions of ascorbic acid. All the millions of cells which make up the body are cemented together just as bricks are held together by concrete. One function of ascorbic acid is to aid the body in maintaining strong cement-like material between the cells. This material is spoken of as connective tissue. The same cement-like substance is used to form the supporting tis-

sues: the cartilage, the ligaments, the walls of arteries, veins, and capillaries, and the basis, or matrix, of bones and teeth which holds the minerals. In the same manner that concrete depends on cement for its strength, so do the substances between the cells and in the supporting tissues depend on ascorbic acid for strength.

Conversely, a lack of ascorbic acid causes a weakening of these tissues. It is as if you tried to make concrete without cement or with only a fraction of the amount needed. The gravel would remain, but it would crumble from lack of material to hold it together.

Ascorbic acid also functions in the production of energy in each of the millions of body cells. Just as the red corpuscles in the blood combine with oxygen and carry it, so does ascorbic acid combine with and carry hydrogen from the breakdown of all foodstuffs. Studies indicate that ascorbic acid is particularly concerned with the using of fats and proteins in the cells.

The third function of ascorbic acid is that of helping the body to fight bacteria, bacterial toxins, poisons, and many foreign substances which sometimes reach the blood stream.

Ascorbic acid and the teeth. If ascorbic acid is inadequately supplied at the time the teeth are forming, the resulting enamel is thin. Few minerals are laid down in it. If the deficiency is severe, the enamel may be entirely missing. A deficiency in early childhood causes the slow growth of the teeth or even cessation of growth for the duration of the ascorbic-acid lack.

After the tooth has erupted, a lack of ascorbic acid causes the foundation of the dentin to break down. This breakdown allows the minerals to be freed, and they are excreted in the urine and feces. The dentin thus becomes porous and soft. If decay penetrates the enamel, it meets little resistance and quickly infects the pulp, causing the tooth to die and eventually to be lost.

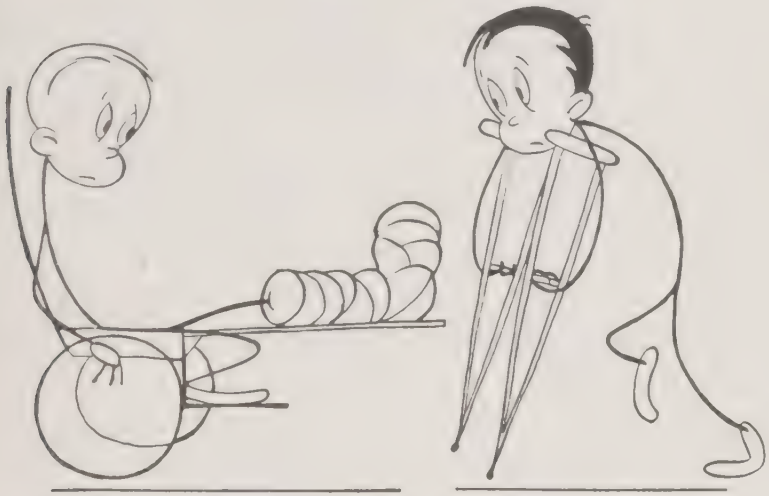
If a partial ascorbic-acid deficiency exists, a bone-like substance is formed, which, although hard, is much more soft and porous than normal dentin. Hemorrhages often occur in the pulp, and pulp stones form which may press against the nerve until the death of the tooth results. A dead tooth always becomes infected and must eventually be extracted.

Foods rich in vitamin C he thought such a bore
That now he must purchase his teeth in a store.

When generous amounts of ascorbic acid are added to the diet of animals which have lacked this vitamin, normal formation of the dentin is resumed within a few hours. Presumably the same change occurs in people under similar circumstances. Six times as much ascorbic acid is required to prevent tooth changes as to prevent scurvy. The widespread partial lack of ascorbic acid in the American diet undoubtedly plays a role in our much too prevalent tooth decay.

Ascorbic acid and the bones. The foundation of the bones is formed of a material which depends on ascorbic acid for its strength. When ascorbic acid is partially lacking, this foundation breaks down, causing minerals to be freed which are

excreted. The bones are left rarefied and somewhat spongy; although hard, they lack the strength of normal bones. Persons who eat too little ascorbic-acid-containing foods therefore have bones which break easily.



Vitamin C is the bones' guarantee
Against doctor's calls and a costly fee.

When the partial deficiency of ascorbic acid occurs during growth, bone formation slows down, or in severe deficiency, may stop altogether. Capillaries in the bones, necessary to carry minerals and oxygen to the growing bony tissue, fail to form. Many of the minerals already laid down are carried away. The bones break easily; the joints may become enlarged; hemorrhage often takes place in the bone marrow; and cartilage formation either ceases or is abnormal. Growing pains, frequently suffered by children, are thought to be caused by an undersupply of ascorbic acid.

An ascorbic-acid deficiency can thus cause a stunting of growth owing to its interference with normal bone development. For example, children grow more in the summer and fall than in the winter and spring. Although other causes

enter into the picture, the greater abundance of ascorbic acid in summer is undoubtedly significant.

As we will see later, the minerals (calcium and phosphorus) are of tremendous value to the body. If eaten in excess, they are normally stored in the ends of the long bones. When vitamin C is lacking, excess minerals cannot be stored. There is no base to hold them. Valuable as they are, they are lost from the body.

If generous amounts of ascorbic acid are added to the diet, dramatic changes take place. In animals, new bone foundation, or matrix, forms within twenty-four hours, and minerals are quickly laid down.[1] These changes take place when adequate ascorbic acid follows a deficiency, whether during childhood or advanced age.

Bones continually change, depending upon the amount of ascorbic acid eaten day after day. Too little ascorbic acid during the winter, followed by a generous intake when summer fruits and vegetables are abundant, produces alternate softening and strengthening of the bones. The same bones, therefore, will be resistant to fracture at one time and will break easily at another.

Many people who never get adequate ascorbic acid have bones which break easily at a minor fall or injury. The amount of ascorbic acid in the blood and urine of people whose bones break easily has repeatedly been found to be abnormally low.

Ascorbic acid and changes in the blood vessels. The walls of all blood vessels throughout the body depend on ascorbic acid for their strength. Although a partial lack of ascorbic acid causes changes in all blood-vessel walls, the walls of the capillaries are most affected. Capillaries, which cannot be seen except under a high-powered miscroscope, have walls made of a single layer of cells, cemented together with minute quantities

[1] **Laid down** = changed into boney structure.

of connective tissue. No other body tissue depends for its strength on such a small amount of cement-like material. If an ascorbic-acid deficiency exists, therefore, the capillary walls break down before those of other blood vessels.

When the capillary walls break, blood is freed into the tissues. This hemorrhage may occur in the intestinal walls, in the bone marrow, in the joints, or at other points which cannot be observed. When the walls break under the surface of the skin, the freed blood discolors to produce a bruise.

Although changes in the dentin of the teeth take place before the capillary walls break down, a bruise is usually the first visual evidence that we lack ascorbic acid. In experimental partial-ascorbic-acid deficiency, internal hemorrhages occur before those on the surface.

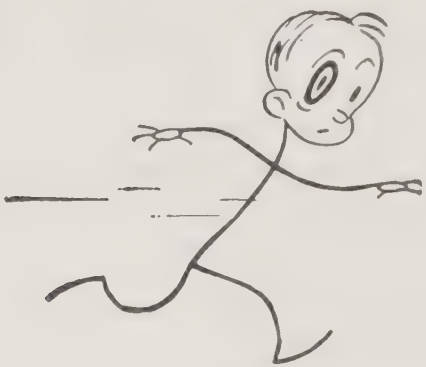
Since girls usually have softer muscles than boys, they are likely to bruise more easily than boys do. Instead of bruises, "pink toothbrush" may be the first symptom of an ascorbic-acid deficiency in men and boys.

The significance of a bruise. Every cubic inch of body tissue is crossed and crisscrossed with thousands of invisible capillaries. Healthy capillaries are elastic, like rubber bands. If you receive a blow when ascorbic acid is abundant in your diet, the capillaries stretch with the indentation of the blow. They do not break, and blood is not freed into the tissues. On the other hand, when ascorbic acid is inadequate, a similar blow causes the capillaries to break. A bruise indicates that thousands of capillaries have been broken and that the blood they were carrying has been spilled into the tissues.

Although it is customary to consider bruises of little significance, they indicate various changes going on throughout the body and are important danger signals. Each capillary in the body is "assigned" a certain number of cells to which it must carry food and oxygen, and from which it must remove wastes.

If capillaries are broken, supplies fail to reach the cells. Authorities estimate that cells lacking oxygen die within a few seconds.

As we have learned in studying vitamin A, dead cells have no protection against bacteria. Dead cells also form admirable food to support the growth of millions of bacteria. When even a partial ascorbic-acid deficiency exists, therefore, capillaries are broken, cells die, and the stage is set for bacterial infection. Whether or not infection actually results depends on the number of bacteria reaching the point where the hemorrhages have taken place and the food supply is waiting.



If you get in the way of a poke and you bruise,
Fresh foods rich in vitamin C you must choose.

Broken capillaries, ever present when ascorbic acid is undersupplied, allow the body to be susceptible to infection in still another way. The broken capillaries offer a means by which bacteria can be transported from one part of the body to another.

Food materials pass freely through the walls of the blood vessels, although red corpuscles are too large to pass through. Bacteria are usually larger than the blood corpuscles; yet they are frequently carried from a dead tooth or diseased tonsils to other parts of the body. They may reach the joints, heart, or

kidney, and cause arthritis or heart or kidney infections. Only when an ascorbic-acid deficiency exists and the capillary walls break down, can bacteria enter the blood stream. The point where a capillary is broken creates an opening large enough to allow bacteria to enter. These bacteria are then carried in the blood to other points where capillary walls are broken. Again openings exist, and bacteria are freed into the tissues, where a food supply already awaits them.

In this manner a bruise, especially one which is caused by a trivial injury, indicates not only that changes are taking place in the bones, teeth, and blood vessels throughout the body; but it tells you that a food supply is being furnished for bacteria and that there is a means of transportation to take bacteria to the waiting food supply. A bruise means that there is danger of infection unless larger amounts of ascorbic acid are included in the diet. When ascorbic acid is abundantly added to the diet, the walls of the capillaries become strong within twenty-four hours.

Ascorbic acid and the gums. In healthy mouths, the gum tissue fits tightly around the base of each tooth. It does not bleed even when brushed vigorously with a stiff-bristled brush. On the other hand, if ascorbic acid is partially lacking, the gums become puffy and spongy and bleed easily. They may become sore and infected. Without ascorbic acid, capillaries break, allow cells to die, and thereby supply food for bacteria. A teaspoonful of average saliva contains about 200,000 bacteria. The ever-present bacteria live on the dead cells of the gum tissue, and consequently an infection develops. A lack of vitamin A or of niacin can also cause infections of the gums.

Dr. Hanke of the University of Chicago carried on an experiment in an orphanage where the diet of several hundred children was considered adequate except for ascorbic acid. The children's gums were badly infected, swollen, and spongy, and

bled easily. Each child was given daily, in addition to the regular orphanage food, two glasses (16 ounces) of orange juice to which was added the juice of one lemon. The gum infections quickly cleared up, and less decay occurred.

Pyorrhea is a disease in which the gums and the bones surrounding the teeth undergo many changes. In many respects it is similar to the mouth condition in scurvy. The gums bleed easily and are infected. Much of the bone is destroyed. Minerals are often lost until an x-ray picture may show the jaw bone to be quite rarefied. Because of the loss of bone, the teeth become loose. In both pyorrhea and scurvy the teeth are resistant to decay. Pyorrhea develops very slowly and is corrected slowly; scurvy develops rapidly and is cured as rapidly.

When guinea pigs are given no ascorbic acid, scurvy appears in from two to three weeks. If guinea pigs, however, are given almost enough ascorbic acid, but not quite enough, in nine months a condition strikingly similar to pyorrhea develops. If slightly less ascorbic acid is given, the pyorrhea-like condition occurs sooner; if slightly more, it occurs later. Pyorrhea most frequently appears at about the age of forty; nine months of a guinea pig's life is equivalent to forty years of human life. It appears probable therefore that people who develop typical pyorrhea have obtained almost enough ascorbic acid over a period of years, and yet not quite enough.

In northern countries and in parts of the United States where the intake of ascorbic acid is limited, pyorrhea is more common than in tropical countries where ascorbic-acid-rich foods are abundant. Studies of patients with pyorrhea have consistently shown the ascorbic-acid values in their blood and urine to be abnormally low; furthermore these low values have been found to be in proportion to the loss of minerals in the bones surrounding the teeth. Other deficiencies, such as

the lack of calcium or vitamin D, frequently occur to hasten the condition.

If pyorrhea is not too far advanced, two glasses of fresh citrus juices taken daily, or the ascorbic-acid equivalent from other sources, together with an entirely adequate diet, will do much to restore mouth health.

Ascorbic acid and the eyes. In healthy eyes, an unusually large amount of ascorbic acid is concentrated in the lens. This ascorbic-acid content is greatly reduced in animals or humans suffering from ascorbic-acid deficiencies. Cataracts have been produced in aged guinea pigs by restricting their ascorbic-acid intake. The lens in the eyes of people sixty to eighty years old has been found to be almost lacking in ascorbic acid.

Studies of the blood and urine show that many people with cataract have less ascorbic acid than people of the same age without cataract. Investigators have reported marked improvement following the giving of large amounts of ascorbic acid, up to 300 milligrams daily, to persons with cataract, especially if the condition is not too far advanced.

Ascorbic acid and healing. The tissue which is formed in the healing of any wound or injury is known as *scar tissue* and depends on ascorbic acid for strength.

During World War I, it was noticed that many wounds were slow in healing or failed entirely to heal. When fresh foods were given the soldiers, the wounds healed normally. Since that time many experiments have been carried out which show that the speed of healing, the strength of the scar tissue, and even the maintenance of strong scar tissue are dependent on the amount of ascorbic acid included in the diet.

Studies were carried out in which groups of guinea pigs with varying amounts of ascorbic acid in their diets were subjected to the same operation. Later, when they were autopsied,

the strength of the scar tissue was accurately measured by determining the number of pounds of pressure it would withstand before tearing. These experiments showed that the animals given generous amounts of ascorbic acid had scar tissue which withstoood many times the pressure of the tissue formed when the animals were given little of this vitamin. The strength was directly proportional to the amount of ascorbic acid given.

The same principle applies to the healing of bones. When ascorbic acid is lacking, the bone foundation, or matrix, fails to form, and the ends of the broken part are unable to knit. Partial lack of the vitamin leads to slow, imperfect healing which leaves the bone weak. This abnormal healing frequently occurs in older persons whose ascorbic-acid intake is notoriously low. Their bones break easily and often fail to knit. When sufficient ascorbic acid is given, together with an adequate diet, the bones heal readily at any age.

Many clinical experiments have been carried out to study the healing action of ascorbic acid. For example, fifty children whose tonsils were removed were given two glasses (16 ounces) of orange juice before and following the operation. They healed much more rapidly and suffered fewer hemorrhages than the same number of children without the extra ascorbic acid. Abundant ascorbic acid has been found to increase speed of healing and to decrease hemorrhage in all types of surgery and after the extraction of teeth. Well-informed dentists and surgeons now insist that their patients eat foods high in ascorbic acid both before and after any type of operation.

In many diseases strong scar tissue must be maintained to prevent reinfection. Examples are the healing of ulcers in the digestive tract and the lesions of tuberculosis. Liberal amounts

of ascorbic acid, therefore, necessary to maintain strong scar tissue, must always be included in the diet.

Determination of ascorbic-acid deficiencies. The amount of ascorbic acid in the body can be measured by determining the strength of the walls of the capillaries. This test is called the capillary resistance, strength-resistance, or fragility test. The apparatus used is like that which physicians employ in taking blood pressure. A rubber band like a flat inner tube of a tire is wrapped around the upper arm. Air is pumped into the tube, causing pressure to be put on the capillaries under the skin. The amount of pressure is kept uniform in all cases and is measured by a column of mercury. A small area (60 millimeters) on the inside of the elbow, where the capillaries are near the surface, is observed under a magnifying glass. When fewer than five broken capillaries can be seen (that is, when a bruise cannot be made artificially), the person being tested is considered to have sufficient ascorbic acid. When the number of broken capillaries is more than eight, (that is, when a bruise can be made) a deficiency exists.

The amount of ascorbic acid in the body can also be gaged by measuring that in the blood. This is a newer test and far more accurate than the fragility test. The amount of vitamin in the blood parallels that in the diet, and is continually withdrawn by the tissues as their supply is exhausted. Persons who are normal have a certain amount of ascorbic acid in 100 cubic centimeters (about one-half cup) of blood; smaller quantities indicate borderline scurvy; still less shows active scurvy.

The measure of ascorbic acid excreted in the urine is also an index of the amount in the body. Small amounts are excreted during a deficiency, and rather large amounts during health.

The body cannot store ascorbic acid in the sense that it can

store vitamin A. The tissues, however, can be either filled, as a sponge saturated with water, or almost empty, as a slightly wet sponge. The ideal state is found to exist only when the tissues are saturated with ascorbic acid.

Extent of ascorbic-acid deficiency. Thousands of people have been tested to determine the extent of ascorbic-acid deficiencies in Americans and in people in other countries. Tests of the strength of the capillaries indicate that from one third to two thirds of the population of the United States are mildly deficient in ascorbic acid. Analysis of the blood and urine show that still fewer people eat sufficient ascorbic-acid-containing foods to produce ideal health.

People in the West get more ascorbic acid than Easterners do. Tests of the ascorbic-acid content of blood and urine of large numbers of college students in Montana, Oregon, Washington, and Utah show that two thirds get adequate amounts. Similar studies of students in Massachusetts and Rhode Island colleges show that only one fourth receive sufficient ascorbic-acid intake.

Other investigations revealed that for the same amount of money spent on food, people living in cities on the Pacific Coast bought three or four times more ascorbic acid than those on the Atlantic Coast.

By the use of the fragility test, seasonal variation was shown. Fewer ascorbic-acid deficiencies were found in the summer and fall, and greater numbers in the spring. Ascorbic-acid deficiency is common among the poor of all ages and includes about 75 per cent of this group; about 25 per cent of the well-to-do people are deficient in vitamin C.

Dr. King of the University of Pittsburgh analyzed the tissues of people dying from various causes. He found the tissues to be extremely low in ascorbic acid when death was due to in-

fections. The ascorbic-acid content of tissues was especially low in almost all cases of older people.

All of these findings indicate that people do not know enough about how to build good health. Often they cannot afford to buy the foods necessary for health. All too frequently they are careless about applying what they do know about building health.

Ascorbic acid and infections. The amount of ascorbic acid in the blood and urine has been found to be unusually low

Low resistance to infections?
Citrus juices cause corrections.

during common colds, fevers, particularly scarlet fever, throat infections, influenza, infections of the sinuses, mastoids, and ear, arthritis, rheumatism, rheumatic fever, and all types of lung infections.

A number of diseases have been produced by bacteria being injected into animals lacking ascorbic acid. For example, by the use of this method, Dr. Rinehart of the University of California and Dr. Sebrell of the United States Department of Public Health have produced rheumatic fever in guinea pigs. Infections of the heart and arthritis, an infection of the joints, have also been produced in the same way. Dr. King of the University of Pittsburgh has produced hardening of the arter-

ies in guinea pigs, lacking ascorbic acid, by injecting bacterial toxins into them. In all cases, the guinea pigs, which were given abundant ascorbic acid and similarly injected, were unaffected except that abscesses usually formed at the place of injection. When the abscesses broke, the bacteria or toxins were thrown out and therefore not distributed throughout the body.

Dr. Jungblut of Columbia University has studied the relation of ascorbic acid to infantile paralysis in monkeys. Virus of this disease was injected into the brains of well-fed animals and those lacking ascorbic acid. Many of the animals given generous amounts of the vitamin remained healthy, whereas 95 per cent of those given no ascorbic acid died with paralysis.

What bearing these experiments have on human health is not known, although they do suggest that ascorbic acid is of great value. It is known, however, that arthritis and heart infections are often associated with dead teeth, diseased tonsils, and infected sinuses, and that rheumatic fever, which attacks malnourished children in northern climates, has greatly decreased since the practice of removing diseased tonsils has become general.

It is obvious that a mild lack of ascorbic acid can do much harm. The changes are swift and destructive, yet all too often hidden. For this reason a bruise should be interpreted as a danger signal. It should indicate to you that your natural resistance is lowered, and that your teeth, bones, and other supporting tissues are becoming less healthy.

Projects

1. Obtain some small fish bones or some chicken bones. Buy concentrated hydrochloric acid from a druggist and soak the bones until all the minerals have dissolved out of them. If no hydrochloric acid is available, soak in vinegar. The base which is left is dependent on ascorbic acid for its strength.

2. Write a composition on what a bruise or bleeding gums can tell you, stating in detail the changes in bones, teeth, joints, blood, urine, scar tissue, and blood vessels.
3. If the father of any student in the class is a physician, borrow his instrument for taking blood pressure. Test several students for ascorbic acid by bringing pressure on the upper arm to 180 millimeters of mercury. With a magnifying glass, observe broken capillaries, if any, on the inside of the elbow. Can you note individual differences?
4. Try to obtain a tooth from a dentist. Ask him to grind the tooth lengthwise in order to expose the dentin. Drop the tooth in concentrated hydrochloric acid. When the minerals have dissolved out, examine the gelatin-like base. What is the purpose of this substance?
5. Compute the amount of ascorbic acid you have obtained in twenty-four hours. Compare with the suggested requirements given on page 220.

Topics for Discussion

1. Why are guinea pigs rather than rats used in experimental studies of ascorbic acid?
2. What are the functions of ascorbic acid? Which function accounts for the following symptoms of scurvy: bruises; low resistance to infections; fatigue; loss of teeth; bones which break easily?
3. Describe changes which take place when ascorbic acid is partially lacking in the following: the capillaries; teeth; bones; eyes; gums.
4. How does a partial lack of ascorbic acid lower the resistance to infections? Why do cells die when ascorbic acid is lacking? Contrast and compare vitamin A and ascorbic acid in regard to building natural resistance. Why is pyorrhea especially associated with lack of ascorbic acid?
5. Are ascorbic-acid deficiencies widespread? What age group appears to be most deficient? Why are there geographical differences in deficiencies of this vitamin?
6. What would a nosebleed indicate to you? What change in diet would you suggest?

Chapter 20

REQUIREMENTS AND SOURCES OF ASCORBIC ACID

In almost no respect is scientific knowledge so meager as in regard to the ideal body requirements. Almost nothing is known as to the amount of vitamins which will promote full health.

Passable versus ideal amount of ascorbic acid. Dr. Szent-Gyorgyi, who received the Nobel prize for his work on ascorbic acid, has pointed out that, in the laboratory, a guinea pig can be kept in what appears to be a healthy condition and can be protected from all detectable symptoms of an ascorbic-acid deficiency by 2 milligrams of ascorbic acid daily. Yet the animal requires many times that amount for protection against bacterial toxins. Similar increases appear to be needed by people.

In this famous doctor's opinion, the ideal amount which an animal needs of any vitamin will be found to be that which it consumes daily in its original environment. When allowed green food, the guinea pig will consume as much as 40 milligrams of ascorbic acid daily. This quantity, twenty times that which appears to promote health, is the amount required for complete saturation of the animal's tissues. Yet the person who might venture to whisper that humans could possibly profit by eating twenty times the amount of ascorbic acid needed merely to give the appearances of health would be considered very radical.

Variations in ascorbic-acid requirements. Since ascorbic acid so readily dissolves in water, it cannot be stored in the body. Its

solubility causes it to be lost whenever water is lost from the body, as in urine and perspiration. The excessive drinking of water causes unnecessary losses of the vitamin. Activities which increase perspiration also increase ascorbic-acid loss.

Studies have shown that ascorbic acid is used twice as fast during manual labor and strenuous exercise as when the body is at rest. The need for the vitamin is therefore doubled for the duration of the activity.

We have seen how infections increase the need for this vitamin. The extent of such an increase is not known and undoubtedly fluctuates.

In adults, the vitamin is found to be needed in proportion to the ideal weight, the larger person requiring larger amounts.

It is obvious that the requirement of ascorbic acid for any individual varies widely from day to day. The amount needed by different people varies even more widely. Many have been found habitually to use more of the vitamin than others.

No harmful effects have been caused by giving excessive doses of ascorbic acid. It is too readily lost in the urine. Since the vitamin is never toxic, undoubtedly it is wiser to err on the side of getting too much than too little.

Requirements of ascorbic acid. A newborn infant has four or five times as much ascorbic acid in its blood as the mother has. Since this amount was put there by nature, it is assumed to be the ideal quantity. If no ascorbic acid is given, this amount falls in three or four days to an extremely low level. Ascorbic acid must, therefore, be supplied by a supplement of fruit juice or synthetic ascorbic acid, if the vitamin in the blood is to be maintained at the level of good health. At least 50 milligrams daily should be given to maintain this level.

Dr. Sybil L. Smith of the United States Department of Agriculture has warned in the *Journal of the American Medical Association* that foods rich in ascorbic acid must be started at an

extremely early age and in much larger quantities than were formerly given. Physicians now prescribe ascorbic-acid tablets supplying 50 milligrams or more to be added daily to the baby's formula or dissolved in its drinking water. A deficiency of even a few days causes the growth of bones and dental structures to cease and allows resistance to infections to be lowered.

As little as 25 milligrams of ascorbic acid are needed daily to prevent scurvy in children, yet studies have shown that 120 milligrams are required to saturate the tissues of three year olds. Much larger amounts are needed during periods of rapid growth, particularly at adolescence.

The Food and Nutrition Board of the National Research Council have recommended the following amounts of ascorbic acid daily:

	MILLIGRAMS OF ASCORBIC ACID
Children	
Under 1 year	30
1–3 years	35
4–6 years	50
7–9 years	60
10–12 years	75
Girls 13–20 years	80
Boys 13–15 years	90
16–20 years	100
Men	75
Women	70

The above figures are meant to be only minimum requirements for healthy people and not those needed to develop the highest degree of vitality. Notice that the suggested amount for a 3-year-old child, for example, is about a fourth of that amount needed to saturate the tissues. Although no one knows the ideal quantity need to produce perfect health, certainly it is at least three times that recommended by the Food and Nutrition Board.

It appears that the requirements are increased with old age.

Many investigators have been impressed by the similarity in the characteristics of scurvy and senility. In both conditions, the bones are notably thin and rarefied, susceptible to fracture, and defective in healing when fracture has occurred. The teeth of the aged and of people with scurvy show the same resistance to decay and a similar rarefaction of the dentine. The changes in the bones and tissues surrounding the teeth are similar. What few fragility tests of the capillary walls have been made in older people indicate that the aged are appallingly deficient in this vitamin. They bruise easily almost to a person. Certainly the older person who wishes to enjoy his last years in the best health possible should plan his diet so that it will contain ample ascorbic acid.

During infections the need for ascorbic acid is greatly increased. In order to break up a cold or other infection, physicians often recommend that a tablet containing 100 milligrams of ascorbic acid be taken every two hours. Still larger amounts of the vitamin have been used in treating conditions known as allergies, in which foreign substances gain access to the blood and act as poisons. Often as much as 1000 milligrams are given in small amounts spaced throughout the day. Poisoning from lead and similar metals have also been treated with good results with massive doses of ascorbic acid. Generous amounts of the vitamin appear to help prevent infections.

Although such quantities are not needed by the healthy person, since the vitamin is not toxic, it is wise to err on the side of obtaining too much rather than too little.

Sources of ascorbic acid. The amount of ascorbic acid one obtains depends not only on the quantity naturally occurring in the food, but on the aging, handling, and preparation of the food before it is eaten.

Among the richest sources of this vitamin are oranges, lemons, grapefruit (canned and raw); tangerines; parsley; water-

cress; tomatoes (canned and raw); fresh strawberries; fresh green or red peppers; and raw cabbage. If money permits, it is well for every person to have a glass of citrus juice daily or its equivalent in fresh fruit. It is possible, however, to obtain adequate ascorbic acid from other foods if sufficient attention is given to it.

A serving of fresh fruit supplies ascorbic acid.

Green, leafy vegetables such as spinach, cabbage, Brussels sprouts, kale, broccoli, dandelion greens, and beet and turnip tops have good ascorbic-acid value, in spite of the fact that almost 50 per cent is usually lost in the water in which these foods are cooked.

Though apples, bananas, canned pineapple, potatoes, green beans, and peas are not especially high in ascorbic acid, they are important sources because of the quantities included in the

diet. Lettuce and escarole are not high in ascorbic acid, but since they are eaten raw, they compare well with cooked vegetables.

All grains and cereals and breadstuffs made from them, all dry beans and peas, lentils, and soybeans lack ascorbic acid. Any seed which is allowed to sprout becomes a fairly good source of ascorbic acid even when cooked. Sprouted grain is recommended as a source of this vitamin at any time when fresh foods are not available.

Cooked muscle meat contains almost no ascorbic acid, but when eaten raw and in large quantities, supplies enough of this vitamin to prevent scurvy. Stefansson, the Arctic explorer, kept his men from scurvy by forcing them to eat uncooked meat. Raw meat also helps to prevent Eskimos from developing scurvy, although their chief source of ascorbic acid is seaweed and algae. They also consume raw liver and glandular meats, which contain much more of this vitamin than muscle meats do.

Butter, cheese, and eggs contain no ascorbic acid. But, as soon as a young chick starts to develop, ascorbic acid is formed. The amount of this vitamin in milk is extremely low, and most of it is lost by pasteurization. It is far more important to destroy the disease-producing bacteria in milk than to preserve the little ascorbic acid it contains.

The effect of climate, soil, and ripening on ascorbic acid. It appears that even the same varieties of foods have different ascorbic-acid contents from year to year, depending on temperature, amount of moisture, and sunshine. For example, fall spinach has been found to contain 50 per cent more ascorbic acid than the same variety grown in the spring. Vegetables grown in one type of soil have higher ascorbic-acid content than the same varieties grown in different soil.

It has been found that certain varieties of tomatoes, apples,

spinach, cabbage, beans, and peas contain twice as much ascorbic acid as other varieties grown on the same soil under the same conditions. Similar variations occur in most fruits and vegetables. The gardeners and canners of the future must give attention to this fact, when the superior varieties become better known.

The ascorbic-acid content of tomatoes and most fruits increases as the fruit ripens. Green peppers increase in ascorbic acid as they become red. Even a single pepper which is red on one side but green on the other will often contain almost twice as much vitamin in the ripe side. On the other hand, young green leafy vegetables and young carrots, tender corn, and peas lose much of their ascorbic acid as they mature. In this case, the vitamin content is highest during the period of most rapid growth.

The effect of handling foods. Storage and temperature greatly affect the ascorbic-acid value of foods. Green leafy vegetables kept at room temperature a few days until wilted lose half of their ascorbic-acid content. Little is lost if they are kept in the refrigerator. Cold-storage apples lost about one fourth of their ascorbic acid in six months, one half in a year. On the other hand, citrus fruits lose only from 10 to 30 per cent in a year of cold storage. About half of the ascorbic-acid content of root vegetables is lost when they are stored for a year. If a food is bruised or mashed in handling, the vitamin is lost much more quickly.

Very little ascorbic acid is destroyed when fruits and vegetables are preserved by quick freezing and storage, although some loss takes place during shelling, washing, and blanching. Losses of from 80 to 90 per cent, however, may occur within a few hours after the food has thawed. This loss can be prevented by starting to cook the food while it is still frozen or by eating such foods as berries immediately after thawing.

Most fresh vegetables and fruits contain enzymes, or oxidases, which cause ascorbic acid to combine quickly with oxygen; thus the ascorbic acid is destroyed. The vitamin is more stable in the presence of acid, which inhibits enzyme action. For example, the vitamin C in canned tomato or citrus juices is retained because the acid prevents the enzyme from acting. Oxidation takes place more quickly at room temperatures than during refrigeration. The preservation of ascorbic acid between the time the food is harvested and eaten is essentially a problem of preventing the action of enzymes which cause the vitamin to combine with oxygen.

Effect of cooking and canning. Water in which vegetables are cooked should first be boiled to allow oxygen to escape before the food is added. Boiling water also causes the enzymes in the food to be destroyed more quickly. For example, leafy vegetables and green peas and beans, started in boiling water and cooked only long enough to be palatable, lose about 25 per cent of their ascorbic-acid content in the water, and 25 per cent is destroyed during cooking. The same foods, started in cold water show almost complete destruction of the vitamin.

The addition of soda to cooking vegetables or to cream of tomato soup causes a rapid loss of ascorbic acid and should be avoided. Adding lemon juice to foods such as carrot salads, however, aids in preserving the vitamin content.

Any contact with copper completely destroys ascorbic acid within a few minutes. Copper cooking utensils, forks, or serving bowls should be avoided.

Overcooked foods and warmed-over foods are practically devoid of ascorbic acid. Potatoes boiled or baked in their skins retain most of their ascorbic acid unless overcooked, but the vitamin is largely destroyed in frying, if the food is sliced.

The ascorbic acid in many foods dissolves in the water in which foods are cooked. Spinach water, for example, may

contain as much ascorbic acid as orange juice. It is obvious then that this water should be saved and used for making soups, gravies, sauces, or even for drinking. Canned vegetables should always be heated in the same water in which the food has been canned, preferably unopened.

Destruction of ascorbic acid in cooking and canning varies, depending on contact with copper utensils, length of time of heating, temperature, access to air, and acidity of the food. Many modern canneries make every effort to prepare their foods with a minimum of loss, and their products often contain more ascorbic acid than home-cooked foods; other canneries carelessly allow most of the vitamin to be destroyed.

Both home-canned and commercially canned tomato juice are excellent sources of ascorbic acid. The acid content protects the vitamin. Commercial canning destroys from 50 to 85 per cent of the ascorbic acid in spinach, asparagus, lima beans, and peas. Because of their acid content, canned grapefruit and orange juice lose only from 10 to 30 per cent of their ascorbic-acid value, and are excellent to use where the fresh fruit is expensive or not available. The potency is lost if the juice is left open to the air for some time before using.

Canned or cooked apricots, peaches, plums, and cherries contain little ascorbic acid. Puréed canned vegetables, despite careful methods of handling, are not good sources of this vitamin.

The effect of drying and pickling. Drying itself is not detrimental to ascorbic acid, but it is almost impossible to prevent oxidation during such a slow process. Dried foods have repeatedly failed to prevent scurvy in times of war. Fruits dried with sulphur retain some ascorbic-acid activity, but, as a whole, are not dependable sources.

Pickling, salting, curing, and fermenting result in an almost complete loss of ascorbic acid. Wines, hard cider, cucumber

pickles, sauerkraut, sauerkraut juice, and similar foods lack the ascorbic acid of the fresh foods from which they are prepared. Commercial orange drinks, unless containing fresh juice, are almost entirely lacking in ascorbic acid. Fresh vegetable juices lose their ascorbic-acid value rapidly because of oxidative enzymes which are freed in crushing and are usually not good sources of this vitamin unless drunk immediately after being made.

The importance of careful preparation. It is obvious that, with such a tremendous number of variations in the ascorbic-acid content of foods, a table giving ascorbic-acid values can be of averages only. The tables on pages 442–465 give the value for fresh, raw foods. Lower values must be expected in unripe foods, those which lack freshness, and those poorly preserved, cooked, canned, or too long stored.

People who cannot afford to buy fresh foods, who lack knowledge of nutrition, and who have poor food habits must depend upon the general food supply to furnish the only ascorbic acid they obtain. Every attempt should be made to conserve the vitamin content in the preparation of foods. Whenever possible, however, fresh, raw foods, such as citrus fruits and raw salads, should be relied upon to supply ascorbic acid.

Projects

1. Make out a diet for an ill person who is allowed no raw foods; it should contain 150 milligrams of ascorbic acid. Discount 50 per cent of value in tables for destruction in cooking.
2. Make out a diet for a boy of fourteen who has asthma and is unable to take any citrus fruits. The diet must contain 100 milligrams of ascorbic acid.
3. Plan a day's menus for a family who can afford no citrus fruits. Suggest how each food may best be prepared. Check the ascorbic-acid content of the amounts likely to be eaten by an average person.

4. Carefully observe how foods are handled in your home and how they are prepared for the table. Can you suggest ways to prevent needless wastes of their ascorbic-acid content?
5. Using any recipe book, look up ways of preparing several ascorbic-acid-rich foods. Is every attempt made to preserve the vitamin content? How can the recipes be modernized?
6. Have someone in the class check the ascorbic-acid intake for twenty-four hours of some person over eighty years of age. Is the supply adequate?

Topics for Discussion

1. Why do ascorbic-acid requirements vary with the following: hot weather; amount of water drunk; exercise; state of health?
2. What harm can be done a bottle-fed baby, one week old, if not given ascorbic acid? When should ascorbic acid be first given an infant? If citrus juices are not tolerated, what can be used instead?
3. How does the ascorbic-acid content of foods vary with the following: withering; climate; state of growth; degree of ripeness?
4. What is the effect of the following on the ascorbic-acid content of foods: room temperature; cold storage; freezing; cooking; canning; soda; copper; re-heating; acidity of food; drying; pickling; peeling; soaking in water; shredding or chopping?

Chapter 21

YOUR NEED FOR VITAMIN D

The vitamin-D-deficiency disease is called rickets. It is a disease of the bones and teeth which occurs largely in babies. The abnormalities of the skeleton, however, are usually carried throughout life, causing unhappiness which might have been wholly prevented by the consistent giving of cod-liver oil during early growth.

Vitamin D is so scantily distributed in foods that it is almost correct to say foods lack it. Only fish-liver oils contain the vitamin in quantities needed to promote health. But, it is now artificially produced in a few foods by exposing them to ultraviolet light. This vitamin is also formed by the action of sunshine on the skin.

The history of rickets. Rickets has been known from antiquity. Many early paintings of infants show babies with signs of typical rickets, indicating that the disease must have been extremely prevalent. That such children were chosen as models also indicates that rachitic deformities were so common as to be considered normal and perhaps even beautiful.

Early writings often refer to the treatment of this disease with fish livers, cod-liver oil, and even ravens' livers. But, its cause and correction were not understood until recently.

In 1918, Sir Edward Mellanby, an English scientist, first produced rickets in dogs by giving them an inadequate diet. He corrected the disease with cod-liver oil. At the time he attributed the recovery to vitamin A. Later, Dr. McCollum of Johns Hopkins University destroyed vitamin A in the oil by

bubbling hot air through it. He found that the heated oil no longer cured eye infections but still corrected rickets. Thus vitamin D was shown to exist.

It was found in 1919 that either sunshine or the light from a mercury-quartz lamp could cure rickets as effectively as cod-liver oil did. Since that time, progress has advanced rapidly. Pure vitamin D in crystalline form was synthesized in 1935. Now ten different forms of vitamin D are known, only two of which have practical importance.

Vitamin D and absorption of phosphorus. The presence of vitamin D is necessary before phosphorus can be absorbed efficiently through the intestinal wall into the blood. In the absence of the vitamin, even though a generous supply of phosphorus is included in the diet, most of it remains in the intestine and is lost in the feces.

Because of the small amount of phosphorus absorbed, that in the blood becomes abnormally low. Normal blood of growing children contains 5 milligrams of phosphorus in about one-half cup (100 cc.). When vitamin D is not supplied, this value may drop to less than 3 milligrams.

The amounts of calcium and phosphorus in one-half cup (100 cc.) of blood of children with and without vitamin D are as follows:

	MILLIGRAMS OF PHOSPHORUS	MILLIGRAMS OF CALCIUM
No vitamin D (rachitic children)	3	7
With vitamin D (normal children)	5	10
Too much vitamin D	8	15

Though the amount of calcium in the blood is usually decreased when vitamin D is lacking, this decrease has not been found to be due directly to the lack of the vitamin. Calcium is largely held in the body by being combined with phosphorus.

When phosphorus cannot be absorbed, part of the calcium has nothing to combine with and therefore cannot be retained. The excess calcium passes from the blood back into the large intestine, where it is lost.

The losses from the intestine of healthy children and of those lacking vitamin D are given below, together with the actual percentage of minerals in the bones of each.

	LOSSES OF CALCIUM IN FECES, PER CENT OF AMOUNT EATEN	LOSSES OF PHOSPHORUS IN FECES, PER CENT OF AMOUNT EATEN	COMPOSITION OF BONE, PER CENT OF MINERALS
Normal children	20–40	15	55–60
Children lacking vitamin D	90–100	60–70	20–30

Vitamin D and bone building. Vitamin D is also believed to control the action of an enzyme, known as *phosphatase,* which is of great importance in the formation of bone. When vitamin D is adequately supplied, this enzyme is concentrated in the cells of the cartilage-like bone foundation. The enzyme acts upon fats and sugars combined with phosphorus, liberating the mineral so that it may be used in building bone. The liberated phosphorus then combines with calcium brought to it by the blood. As this action continues, both minerals become so concentrated in the cells of the bone foundation that they *settle out,* (just as sugar crystallizes in a syrup pitcher). In this way minerals are laid down, and bones are hardened.

When vitamin D is lacking, the enzyme phosphatase leaves the bone foundation and passes into the blood. Phosphorus, which is already meagerly supplied because of poor absorption, can no longer be liberated from foods inside these cells; therefore, no combination with calcium can take place, and no minerals are laid down. Growth may completely cease. If a little vitamin D is supplied, some phosphatase is present, and

growth proceeds slowly. The deposition of calcium and phosphorus in skeletal tissue throughout the body is therefore in direct proportion to the amount of vitamin D furnished.

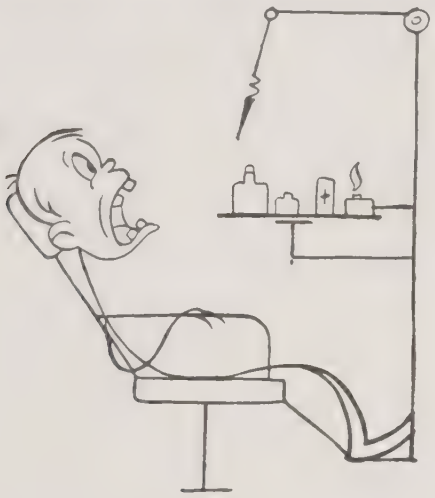
It is believed that minerals are laid down in growing teeth in the same manner as in the bones. When vitamin D is amply added to the diet, phosphatase again accumulates in the bone cells. The formation of normal bone is resumed.

Recognizing vitamin-D deficiency in babies. It is more important to be able to recognize a deficiency of vitamin D than of any other vitamin. Although the majority of deficiencies of minerals and other vitamins can be overcome at any age, lack of vitamin D causes permanent injury which can never be repaired. Millions of people have gone through life homely and malformed because the need for this vitamin was not recognized and therefore not supplied.

A lack of vitamin D generally shows itself in children from six months to two years of age. In mild deficiencies, the child is restless and fretful and perspires easily, especially on the forehead. The foundations of the long bones become enlarged at the ends, particularly at the wrists and knees. It is an enlargement of the bone base which is spoken of as knock-knees. An enlargement is especially noticeable in the forehead, which appears prominent and gives a somewhat square shape to the head and a deep-set look to the eyes. The chest bone, or sternum, also enlarges and protrudes into the shape called a *pigeon chest.* The ribs enlarge at their junction below the arms and turn inward. The resulting small chest capacity affects the lungs and internal organs, creating susceptibility to lung diseases. Such changes are found in most narrow-chested people. The pelvic bones, like those of the chest, fail to develop and widen normally.

The baby or small child without sufficient vitamin D may appear to be well fed or even fat. It fails, however, to grow in

length. The bone which has already formed becomes demineralized. The leg bones lack strength to such an extent that they become easily bowed if the child is old enough to walk. The child's muscles, which are soft and stringy, result in poor posture as do those of older children lacking calcium, phosphorus, and vitamin D. The stomach protrudes into a potbelly, and the shoulder blades extend into angel wings.



Lack of vitamin D brought him trouble aplenty.
Just four teeth are left, and he's still only twenty.

Tooth development slows down or ceases. Whereas normal teeth come in at about six months, a lack of vitamin D may delay their eruption until the child is a year old. The bones forming the dental arch are frequently so poorly developed and narrow that crowding and overlapping of teeth are caused.

If vitamin D is amply added to the diet before the child is a year old, normal growth takes place, and little visible permanent harm is done. However, if the vitamin is not given or if it is added too late, the deformed bones harden and can never be changed. Such abnormalities as knock-knees, bowed legs, protruding forehead, small dental arch, and defective teeth

remain to cause distress, unhappiness, and lack of beauty throughout life.

Severe deficiencies of vitamin D were prevalent until a few years ago, but they have largely disappeared since the feeding of cod-liver oil to babies has become general. In milder forms they still exist to rob the person of physical beauty which should be the right of every individual.

Vitamin-D deficiencies in older children. A dietary lack of phosphorus or calcium, or of both, can cause bones to grow abnormally as well as the lack of vitamin D. Babies, who are almost universally fed milk, have a diet unusually rich in both calcium and phosphorus. The principal cause of poor bone formation in infants is therefore the lack of vitamin D.

In the years following World War I, the shortage of food in Germany, Hungary, and Austria caused the appearance of abnormal skeletal structures not due to vitamin D alone but to the lack of calcium and phosphorus as well. Children whose bodies had been well formed developed many malformations. This condition occurred even in boys and girls in the late teens.

Not only did normal bone growth cease, but bones already strong became rarefied and sufficiently weak to bend. Knock-knees, bowed legs, and chest abnormalities resulted. Symptoms appeared such as curvature of the spine, sway-backs, curved shoulders, and pain in the bones themselves. During the winter months, when no sunshine was available, the cases were more advanced.

Later when the diet was improved, the growth of bone was resumed, but the defects and the stunting of growth were never completely corrected. Poor physical development and bone deformities may be seen in these countries today in people who were growing at the time of the post-war starvation period.

Vitamin-D deficiencies in adults. As a person becomes older,

phosphorus is more readily absorbed into the blood without vitamin D. Even though vitamin D appears to be lacking, visible signs of destruction of bones in adults are almost never seen in America except in X-rays. Severe forms of rickets, nevertheless do occur in adults.

Perhaps the best example of adult rickets has been described by Dr. McCarrison, an English physician, who has spent many years working in India. He tells of the development of rickets among women who observe *purdah* (a religious custom of seclusion beginning in early adolescence). These girls and women must not allow men, other than their husbands, to look upon their faces. They veil their faces carefully and rarely venture from their dark homes. No food containing vitamin D is eaten. Almost no sunshine touches them. Their diets are inadequate in both calcium and phosphorus. This condition is especially true of the poor.

The symptoms of the disease and the bone changes are similar to those found in rickets in older children. The leg pains become so severe the women are often unable to walk. The complete loss of teeth before the age of twenty is the rule rather than exception. The addition of cod-liver oil corrects the condition even though no other change is made in the diet. This proves beyond doubt that this vitamin is of value at any age.

Adult rickets has also been observed in China and Japan. In Vienna in 1919–20, the middle-aged and older people of the poorer classes suffered to a great extent from the disease. A waddling gait developed, and patients complained of pain at every movement of the body. The disease was effectively treated with cod-liver oil without other improvement in diet. It almost disappeared in the summer, when sunshine was available. When the food was later improved to supply more calcium and phosphorus, the disease did not return even in the absence of vitamin D.

Extent of rickets today. A few years ago, even severe forms of rickets were extremely common. The disease affected both rich and poor and was especially severe in crowded sunless sections of large cities. As many as 90 per cent of the children were rachitic. The majority of people now living carry dental and bone abnormalities throughout life which were caused by rickets during their infancy.

Since the giving of cod-liver oil in some form to most babies began, it has been assumed that the disease has largely disappeared. However, studies show that it still exists as a far more serious and widespread menace to health than is commonly recognized.

A survey was made to determine the extent of rickets in two cities representative of the northern and southern parts of the United States. In both Portland, Oregon, and San Diego, California, large numbers of five-year-old children from all social classes were carefully examined for evidences of this disease. In both cities more than 80 per cent of the children had received vitamin D in some form. Yet 95 per cent of the children in Portland showed four or more signs of rickets. Similar evidences of rickets were found in 73 per cent of the children of of San Diego, a city which has perhaps more hours of sunshine than almost any other in America.

There is little doubt but that similar figures would be obtained from other cities throughout the country. If studies were made of the crowded sections of Chicago and New York, the report would probably be even more appalling. Yet rickets can be so easily prevented that its very presence today is a disgrace to a nation which falsely prides itself on the health of its children.

There are many reasons why rickets has not been prevented. Too small amounts of the vitamin D have been given. Its use has been irregular. By the time a child is two or three years

old, frequently no vitamin D is supplied in any form, despite the fact that the child is growing rapidly and needs the vitamin daily. Too much ignorance exists concerning the quantity of vitamin D necessary to prevent the disease, and the need for its continuance until adulthood. Only sound health education can eradicate the disease.

Vitamin D in relation to height. The taller races of people are invariably those which are generously supplied with both vitamin D and calcium. Although a lack of any vitamin or mineral may lead to a slowing or cessation of growth, vitamin D is of particular importance because, without it, the skeleton itself is unable to reach its normal size. The height of a person, provided the diet is entirely adequate in other respects, is directly proportional to the amount of vitamin D included day after day throughout the entire period of growth.

We have all known short men whose entire personalities are warped because of their stature. It is said that thousands upon thousands of dollars are spent each year by short men for stretching devices which claim to add inches to height. When growth has stopped, nothing can be done to make the bones grow an inch longer. On the other hand, the boy of fifteen or sixteen is still growing, and the addition of vitamin D can help him to gain the desired height.

Vitamin D and the teeth. Mrs. May Mellanby, wife of the English scientist who first produced experimental rickets, has probably done more work on the relation of rickets to teeth than anyone else in the world. She points out that frequently such slight degrees of rickets exist as to be unrecognized but that the disease is sufficient to interfere with the normal development of teeth. She examined several hundred baby teeth and found 80 per cent of them structurally defective. She also examined over twelve hundred permanent teeth. These begin to form at about the fourth month of life. Again 80 per

cent showed signs of lack of vitamin D during the formation period.

According to Mrs. Mellanby, the extent of decay was in direct proportion to the structure of the tooth. Of the poorly developed teeth 90 per cent were decayed. On the other hand, 90 per cent of the normal teeth were free from decay.

A lack of vitamin D also causes profound changes to take place in the bones of the mouth. Narrow arches, causing crooked, overlapping, and protruding (buck) teeth result when vitamin D is inadequately supplied. Too little of this vitamin may cause the upper jaw to develop more than the lower. This gives the person the appearance of having little or no chin. The reverse may also be true. A defective bite and teeth out of alignment are also signs of changes in the dental structures which are usually due to a lack of vitamin D. Thumb sucking or mouth breathing may exaggerate the conditions, but these habits have little effect on children whose jaw bones are hard and well calcified because of an abundance of vitamin D.

Almost every case where teeth must be straightened is the direct or indirect result of too little vitamin D when the jaw bones were developing. The tremendous amount of money spent upon straightening teeth might be largely avoided if vitamin D had been amply supplied throughout the entire period when the teeth were developing. Even impacted teeth, which fail to erupt and often call for painful and expensive surgery, may be produced experimentally when vitamin D is not adequately added to the diet.

Vitamin D and energy. Experimental animals lacking vitamin D have been found to burn less sugar than those supplied with this vitamin.

As we have seen, when vitamin D is not adequately supplied in the diet, phosphorus from foods, even though generous, is

not well absorbed into the blood. Phosphorus is a carrier of sugar, taking it through the intestinal wall and from the blood stream to be stored as glycogen. Later, before energy can be produced from sugar, the sugar must again combine with phosphorus. This fact remains true whether the sugar comes directly from the blood or from the breakdown of glycogen. It is only natural then that a lack of vitamin D, hence a lack of phosphorus, would interfere with the production of energy.

By means of a scientific test, it is found that animals with rickets burn only fats in spite of the fact that half of their food may be carbohydrates. When vitamin D is added to the diet, this test shows that sugar is again being used and that energy is produced normally.

Animals hibernate only in late fall when they receive little or no vitamin D from sunshine. Certain animals, among which the hedgehog has been especially studied, do not hibernate if given vitamin D. Too much energy is produced to allow long sleep. As the supply of the vitamin decreases, the animals burn less sugar and become more sluggish; in hibernation they use an extremely small amount of food.

Children lacking vitamin D have also been found to burn less sugar. The ability of the body to combine sugar and phosphorus in the muscles, a necessary step in the production of energy, is greatly reduced in rickets. Children with rickets have been found to have higher than normal amounts of sugar in their blood and to lose sugar in the urine. This loss is caused by a lack of sufficient phosphorus to store the sugar efficiently as glycogen. Too little phosphorus also causes incomplete absorption of sugar. For this reason, children lacking vitamin D have been found to lose sugar in the feces.

Energy is again produced normally when vitamin D is added to the diet. The amount of phosphorus in the blood increases to normal. This phosphorus increase allows sugar to be car-

ried efficiently through the intestinal wall, to be laid down as glycogen, and to be burned as needed.

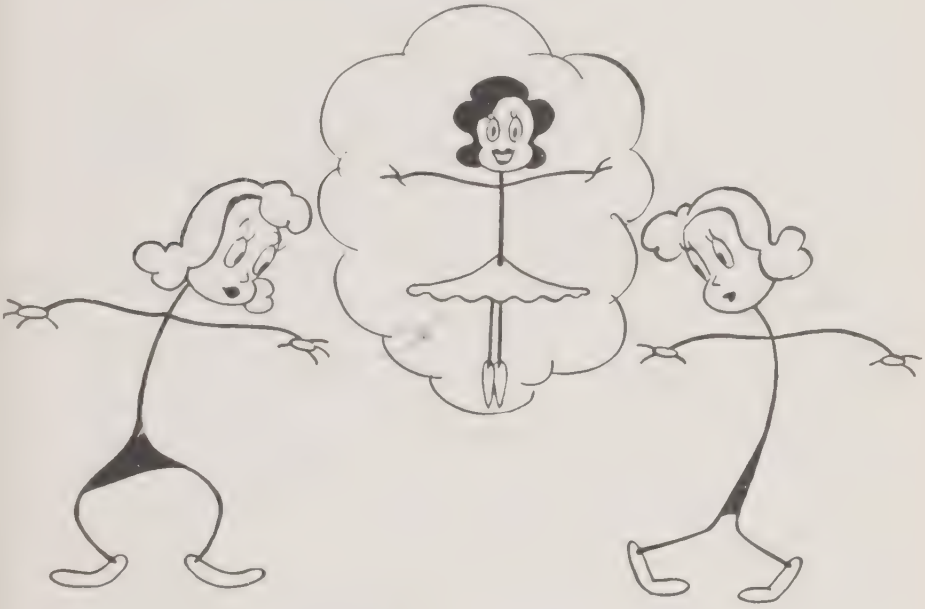
The relation of vitamin D to energy production brings up a number of problems which have not been thoroughly investigated. A great many people fail to receive vitamin D, particularly during the winter months. Is a deficiency of vitamin D, through interference with sugar absorption and energy production, partly responsible for the general sluggishness so many people feel during the winter? The person whose body cannot properly use sugar usually craves sweets. Could a lack of vitamin D be responsible for the fact that so many growing children crave sweets? Their needs for vitamin D are high during growth. The present findings suggest that the lack of vitamin D may be responsible. Certainly the daily amount of vitamin D should not be left to chance.

Relation of vitamin D to eyes. When puppies are restricted to a diet deficient in vitamin D and calcium, there is a weakening of certain parts of the eyes. These changes are considered by scientists to be identical with those frequently found in the eyes of children and adults. They result in the inability of the eyes to bend light rays sufficiently and hence cause nearsightedness, or *myopia.*

The blood analysis of children who suffer from nearsightedness has shown either the calcium or the phosphorus values, or both, to be below normal. Although the relation of vitamin D to nearsightedness has been little studied, an adequate diet, together with generous amounts of this vitamin, has resulted in correction of the eye condition in some cases.

Relation of vitamin D to features. People who have had severe rickets are rarely great singers. The sinuses and other cavities where sound resounds are too small and malformed. Conversely, the greatest singers of the past have largely come from sunny Italy, where rickets are unknown.

The lack of vitamin D frequently leads to the malformation of the bones of the face. The abnormal formation is usually seen in a narrow face, small chin, underdeveloped cheek bones, and protruding or receding jaws.



These girls as small babies were not cod-liver oiled.
So their hopes to be dancers were long ago spoiled.

Relation of vitamin D to beauty and handsomeness. It is obvious that an adequate intake of vitamin D during the entire growth period greatly influences beauty and attractiveness. Certainly no person is lovely with knock-knees, bowed legs, or an enlarged forehead. Many a girl who desires to be a dancer has found her wish impossible because of her crooked legs. The title of Miss America has never been given to any girl without beautiful teeth. Even minor defects in teeth go far to spoil an otherwise pleasant appearance. Certainly the tall, well-built boy or man is handsomer than the narrow-chested, short one.

In many cases irreparable harm has already been done. May the knowledge of the need of vitamin D cause you to resolve that your children will receive it daily throughout their entire growth period.

Case History

Tony C. was about eighteen months old when his mother first brought him to the clinic. It was in the crowded tenement section of lower New York City, before cod-liver oil was routinely given to babies. His parents had come from sunny Sicily and had never heard of sunbaths or bone diseases.

Tony's forehead was bulging and too large. His shoulders were rounded, and the shoulder blades and abdomen protruded. He had a pigeon chest. The chest itself was narrow, and the lower ribs flared outward. His teeth were slow in erupting, crooked, and overlapping, but it was his legs which caused his mother to bring him to the doctor. She had tried to straighten them herself. The lower part of his body was wrapped like a mummy to a board, splint fashion. There had been no running or playing for Tony.

A visit to their home explained why every child in the district had rickets. No sunshine ever penetrated the tenement. The halls, unlighted during the day, were as black as midnight. There were no elevators, and Tony was too heavy to be carried up six flights of stairs to the roof, where a little sunshine penetrated the city smoke. Cod-liver oil was given three times daily. Marked improvement resulted, but Tony will carry the signs of rickets throughout life. Vitamin D was not started soon enough.

Activities

1. Observe people closely and see how many signs of mild rickets you can identify. Note the shape of the face, forehead, jaw bones, chest, back, and legs. Are bone abnormalities more common now among younger or older people? Why?
2. Observe people whom you consider beautiful or handsome, and contrast them with others you think of as homely. What makes

the difference? Are any of the differences due to skeletal development?

3. Ask mothers of children from three to ten years old if their children are receiving any form of fish-liver oil. If not, are they receiving any other form of vitamin D? Can you influence the parents to give the vitamin daily?

Topics for Discussion

1. How does vitamin D interfere with energy production? What is the relation between the vitamin and hibernation?
2. Is it more important to be able to recognize mild than advanced forms of rickets? Why? Why does a mother so frequently consider her children to be healthy when actually they are not? How can money be saved by giving some form of fish-liver oil throughout the growth period? Should vitamin D be taken throughout life? Why?
3. How much calcium and phosphorous are normally found in about one-half cup of blood? How much occurs when vitamin D is undersupplied? What per cent of the amount of calcium and phosphorous eaten is normally lost in the feces? What per cent may be lost when vitamin D is not included in the diet?

Chapter 22

THE VALUE OF SUNSHINE

From earliest times a few physicians recognized the value of sunlight for health in general and especially for the treatment of rickets. As early as 1890, a study was made of rickets throughout the world, and freedom from the disease was found to parallel the amount of sunshine. When rickets was produced experimentally, it was shown that the disease could be either prevented or cured by adequate sunlight or light from the mercury-quartz lamp. Such a lamp produces light rays known as ultraviolet, which are identical to the shortest rays of the sun.

Irradiated foods. A few years later, Dr. Steenbock at the University of Wisconsin made the remarkable discovery that, if the food which produced severe rickets in animals was first exposed to ultraviolet light, the disease did not develop. By irradiating each food separately, he found that fat alone acquired vitamin D. Further analysis showed that a wax-like substance known as *ergosterol* changed into vitamin D after treatment with ultraviolet light.

Ergosterol is not the active vitamin but the provitamin, just as carotene is provitamin A. Exposure to ultraviolet light, either from a mercury-quartz lamp or from sunlight, changes ergosterol into the active vitamin D. This exposure to ultraviolet light is spoken of as *irradiation.*

Action of sunshine on the skin. For a long time, it was thought that the provitamin ergosterol in the skin was changed by sunlight into vitamin D, and then was carried by the blood

throughout the body. This conception, however, is beginning to be doubted.

Rachitic rats, which normally recover when exposed to sunshine, fail to recover if prevented from licking their fur. The cat, which has long been given credit for unusual cleanliness, may in reality be taking vitamin D for dessert. Chicken feathers, when exposed to the sun, contain vitamin D, and chickens usually obtain this vitamin by eating their own feathers. But, if the gland which oils the feathers is removed, no vitamin D is formed, and chickens quickly develop rickets.

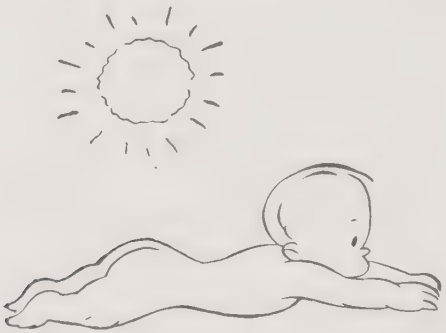
Carnivorous (meat-eating) animals are careful to eat both the fur and feathers of their prey, thus obtaining their supply of vitamin D. Animals in zoos are often fed only muscle meats. Even the addition of bones and glandular organs has not protected them from rickets, whereas the addition of fur or feathers has. Rabbit fur and sheep's wool contain vitamin D on the back but not on the under part which is untouched by sunlight. Highly-prized show horses and race horses fail to thrive when washed frequently with soap, and their colts often develop active rickets.

Now it appears that the oil glands in the skin secrete the provitamin on the surface of the skin, fur, or hair. After the oil is acted upon by sunlight, the vitamin D is either absorbed back into the body through the skin, or licked off, or eaten. It has been found that rachitic babies, when washed so thoroughly as to remove all the provitamin from the skin, fail to recover when exposed to the sun. Water alone removes much less of the oil than when used with soap. Swimming and playing with the hose on a hot day probably do little harm.

Practical application of present knowledge. The excellent bone development and beautiful teeth of the primitive races have frequently been pointed out as an outstanding proof that the people obtained sufficient vitamin D. In the light of recent

findings, it is seen that primitive people, by washing less frequently than we do, have conserved their supply of vitamin D.

The findings bring up a number of practical precautions which have not been amply considered. People who bathe frequently with soap should not rely on summer sunshine for their vitamin D but should take some form of the vitamin throughout the summer months. Children should have their baths at the end of the day, instead of in the morning.



Everyone of us babies the doctors agree,
Should sunbathe daily for vitamin D.

If a baby is put in the sun before his bath, there should be time afterward to allow the vitamin to be absorbed into the blood. The length of time is not known. It is probably not wise to wash with soap if the full value of the sunshine is to be gained. The more recent practice of washing a baby with oil instead of water causes the child to be more healthy, probably because a larger amount of vitamin D is obtained in this manner.

The power of sunlight. Smoke, fog, and haze, the distance of the sun from the earth, and the reflection of sunlight all influence the amount of ultraviolet rays which reach us.

Fog and dust in the air limit the amount of ultraviolet light which can reach people who live in cities. A study made by the Chicago Department of Health revealed that twice as much

ultraviolet light reached the tops of the skyscrapers as penetrated to the streets below. In the open country outside large cities, the amount of ultraviolet light has been found to be about 50 per cent greater than in the city itself.

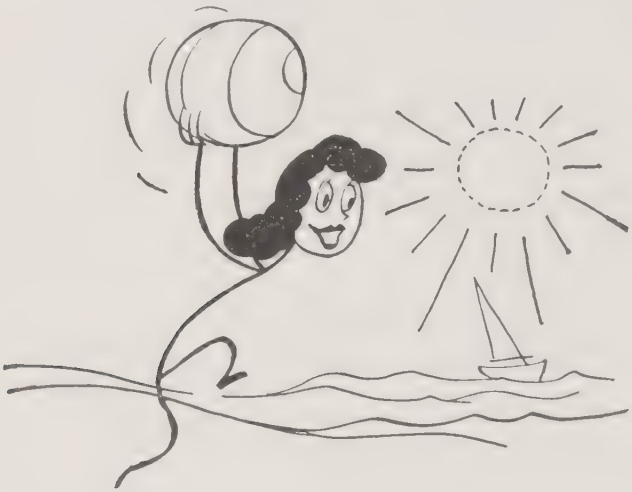
The United States Public Health Service made a survey of fourteen different cities and found there was 50 per cent more of the active rays in the cleaner cities than in the smoky ones. In some cases, there was even 100 per cent of difference. The extent of the pollution of the air was shown by a study which revealed that, during a typical year 300,000 tons of soot, tar, cinders, and ashes were discharged into the air over New York City. In certain areas of the city, soot and dust were found to settle at the rate of 1800 tons per square mile per year. Figures even higher were reported for small cities where soft coal was burned in factories and homes. Such findings as these emphasize the need for including adequate vitamin D daily in the food and not relying on sunshine at any time of the year.

Despite the number of sunny days in California, children in the central part of the state frequently develop rickets because of the haze. In San Francisco, the disease has afflicted as many as 90 per cent of the babies, because the sunlight cannot penetrate the fogs. Children in certain parts of the tropics have developed the disease because of excessive cloudiness and the long rainy season.

During the winter, the position of the sun is such that, on our part of the earth, few of the desirable ultraviolet rays reach us. Before cod-liver oil was generally used, almost all the children in the north temperate zone showed at least a mild form of rickets sometime during the first two years of life.

Experiments have shown that rats on rickets-producing diets are protected from the disease by only five minutes daily of sunshine in June, July, and August, whereas almost three hours of sunshine are needed in December. Intermediate values were

found for the other months. When the disease was already developed, four and a half hours per day of sunshine in December and January caused no healing. It is now generally agreed that, in the temperate zone, vitamin D from the sunshine should not be relied upon except during the months of June, July, and August.



The seaside beauties get vitamin D
From sunlight reflected by waves of the sea.

The intensity of sunlight in any given season varies widely. In high altitudes, the air is so free of smoke, fog, and haze that much ultraviolet reaches the earth. For this reason it is easy to acquire a severe sunburn in the mountains. At the beach, one receives a double dose of sunlight, for in addition to the direct rays, the ultraviolet is reflected by the water. Snow cannot absorb and therefore reflects the vitamin-D-producing rays. Sunlight is reflected from buildings and other objects, so that on bright days a person is benefited by sitting out of doors even though he may be in the shade. *Skyshine*, a term given to the light on cloudy days, has been found to have about half the value of direct sunshine at the same season.

Effect of window glass and clothing. Ordinary window glass does not permit the active rays of sunshine to penetrate. Inexpensive glass has now been developed which, when new, transmits about 50 per cent of the ultraviolet light but which gradually changes until only about 25 per cent passes through it. This glass is now being used by some hospitals, zoos, and chicken raisers. It should be used in all school buildings and homes.

Clothing excludes much of the ultraviolet light. Dark colors, wools, silk, or many layers of any material prevent the penetration of sunlight. One layer of light-colored, loosely woven material such as cotton, linen, or rayon allows much ultraviolet to reach the skin. The fashion that permits girls to wear ankle hose, sunsuits, and backless dresses, and boys to exercise in trunks is a commendable one.

Light from certain types of lamps causes vitamin D to be formed on the skin. These lamps may be purchased inexpensively. In view of the tremendous amount of tooth decay and the small percentage of older children who receive any form of fish-liver oil regularly, such lights should be used in every schoolroom. Even though a small amount of the skin is exposed, the vitamin formed is carried throughout the system, and the whole body is benefited.

Vitamin D in soaps and cosmetics. Soaps have appeared on the market advertized to contain vitamin D. Obtaining vitamin D from soap is obviously ridiculous, for it is not customary to go about covered with soapsuds until the vitamin may be absorbed through the skin.

Vitamin D added to cold creams is likewise of little value. No one knows the amount of the vitamin which should be applied to the skin, or for what length of time it should remain there to give a daily requirement. To prevent rickets in animals, it has been found that ten times more vitamin D must be

applied to the skin than need be given by mouth. Since most oils contain provitamin D (ergosterol) the practice of covering the skin lightly with oil to prevent sunburn is probably beneficial.

The giving of vitamin D in the summer. In the past, it has been customary to discontinue the giving of cod-liver oil or other sources of vitamin D throughout the summer. Because of the influence of fog, clouds, smoke, and haze, the amount of clothing, the time of exposure, and the removal of the provitamin by bathing, it is obvious that even summer sunshine becomes an unreliable source of the vitamin. Moreover, small children who have actually enjoyed the taste of cod-liver oil when receiving it daily often dislike the taste after a period of several months without it; therefore, the practice of giving the oil is often discontinued altogether. If the daily routine had not been interrupted, the children would no doubt have gone on taking the cod-liver oil indefinitely, without acquiring a distaste for it.

It cannot be overemphasized that some reliable form of vitamin D should be given daily throughout the entire growth period. True, the child of three needs it more than the child of ten. The child of ten needs it more than the boy or girl of fifteen. But all unquestionably require a daily amount of the vitamin, for growth, bone build, and dental development suffer when it is not supplied.

The taking of sunbaths. The value of sunshine must not be overrated; neither should it be underemphasized. Sunbaths offer a definite contribution to health.

Certain precautions should be taken in sunbathing. Sunburn should be avoided. Fair-skinned people, particularly, should be exposed to the sun only a few minutes at first, and the time increased as their skin becomes more accustomed to the rays. For the infant, a sunbath of three minutes is sufficient

A daily sunbath is advantageous for persons of all ages.

during the first week. Gradually this time may be increased to half an hour or more daily. As reflex action automatically protects the baby's eyes from the sun, they need not be covered.

The sun's rays are most direct at noon. For this reason, sunbaths are particularly beneficial when taken between 11 A.M. and 1 P.M. Before 10 A.M. and after 3 P.M. little value is obtained from sunlight. Sunbaths need not be taken with the entire body exposed. The vitamin absorbed from the uncovered skin is carried by the blood throughout the entire body. However, the greater the exposure, the more benefit derived. Ideally every man, woman, and child should receive at least half an hour of sunlight daily when the sun is most directly overhead.

Projects

1. Ask your family to buy a lamp giving ultraviolet light. Place it near the dining-room table and burn it during meals
2. If your grandparents are living, ask them if they have ever taken a sunbath. Do your findings throw any light on why the bones of older people are apt to break easily?
3. Look up the issues of *Life* which featured smoke conditions over large cities. Do you now understand why it is essential to continue the use of vitamin D?
4. Obtain a large ball representing the sun and a small globe of the earth. Locate the place where you live on the globe. Then rotate the earth around the sun, in the manner to represent each season, and each part of the day. Can you see why the shortest rays of the sun fail to reach you in the fall, winter, and spring and in the early morning and late afternoon, even in midsummer?

Topics for Discussion

1. What appears to be the action of sunshine on the skin? How is vitamin D distributed throughout the body? Why have primitive races received more vitamin D than modern man has?
2. Should sunshine be relied upon as the sole source of vitamin D during the summer? Give reasons for your answer. How and when should a sunbath be given?
3. How do the following affect the intensity of sunshine reaching us: fog; smoke; clouds; window glass; clothing; season of the year; time of day; presence of snow or water?

Chapter 23

THE SOURCES OF VITAMIN D

No natural food which we customarily eat contains enough vitamin D to furnish an adequate daily supply. A small amount occurs in egg yolk. Summer eggs contain more than winter eggs. The feeding of cod-liver oil or other forms of vitamin D to hens increases the vitamin-D content of the yolk, but never at any time is the quantity significant.

The oils of sardines, herring, salmon, and tuna fish contain some vitamin D, as do fish eggs. The oils of fish-eating birds and animals contain vitamin D. These oils protect the Eskimo from rickets. People who eat large amounts of fish, as do the Russians and Scandinavians, show the tall build which indicates sufficient vitamin D during growth. Yet, many show prominent foreheads and other signs of rickets, developed before fish was eaten.

Ordinary milk contains little vitamin D. Winter milk averages about 5 units per quart. Summer milk may be as high as 40 units per quart. Since the vitamin dissolves in fat, what little occurs is found in the cream and hence in butter.

Vitamin-D milk. The American Medical Association has endorsed *vitamin-D milk,* and health authorities have recommended it widely. Since there is almost no vitamin D in ordinary food, milk is the most logical artificial carrier. One function of the vitamin is to aid the body in using calcium and phosphorus, both of which are abundant in milk. Milk is generally and regularly used by most infants and children; also they need larger amounts of the vitamin than adults do.

Vitamin-D milk may be produced by feeding cows either fish-liver oil or yeast which has been exposed to ultraviolet light. Such milk averages about 400 units per quart. A vitamin-D preparation, *irradiated viosterol,* is sometimes added directly to ordinary milk and standardized to 400 units per quart.

Often the milk itself is irradiated. In this case it contains 135 units per quart. More vitamin can be produced by longer irradiation, but the milk acquires a distasteful flavor. Canned or evaporated milks are also irradiated and usually contain 400 units in the larger cans.

Vitamin D in milk has been found to be more effective than

Very few foods contain vitamin D

evaporated milk (4 ounces)	*100 units*
fresh vitamin-D milk (4 ounces)	*50 units*
one egg	*50 units*
one tablespoonful of cod-liver oil	*1700 units*

vitamin D from any other source. But its use should depend upon the price asked. If it were always sold at the same price as other milk, its use should be universal. Usually it is one or two cents higher than ordinary milk. The amount of fish-liver oil which may be purchased for that additional money would supply more vitamin D than the milk, plus several thousand units of vitamin A as well. In such cases, it is wiser to buy ordinary milk and supplement it with some form of fish-liver oil.

Irradiated foods. Many foods contain the provitamin ergosterol, which becomes active vitamin D upon irradiation. Several irradiated foods have appeared on the market. For example, bread containing 140 units per pound loaf may be bought. A few cereals now contain vitamin D. Though these are excellent supplements to the diet, they contain too little vitamin D to be considered adequate.

Fish-liver oils. By far the richest natural source of vitamin D is fish-liver oils. Even today, with many new preparations on the market, nothing surpasses the time-honored tablespoonful of liquid cod-liver oil daily as a supply of vitamin D, at any age in life.

Teaspoonful for teaspoonful, halibut-liver oil contains much more vitamin D than does cod-liver oil. Cod-liver oil, however, is usually taken by tablespoonfuls; halibut-liver oil by drops, because of its high vitamin-A content. Therefore, the vitamin-D content is lower in the amount of halibut-liver oil usually prescribed than in cod-liver oil.

Ergosterol, which occurs in a number of oils, can be irradiated to form an extremely potent source of vitamin D. Diluted in corn oil or sesame-seed oil, it is sold under the name of *viosterol*. When viosterol is added to halibut-liver oil, the combination compares favorably with cod-liver oil in vitamins A and D.

Viosterol is sold alone and is extremely valuable in the treatment of active rickets where large amounts of vitamin D are needed. Unfortunately it contains no vitamin A, as do all natural fish-liver oils. It should not be used alone unless prescribed by a physician.

Shark-liver oil, salmon-liver oil, and a number of other fish-liver oils are excellent sources of vitamin D. Many, however, are low in vitamin A and thus have not gained popular commercial use. These oils are often for sale in poultry-feed stores, and if they are known to be pure and clean, they form a cheap source of vitamin D.

Malts and concentrates. Because so many people find the taste of cod-liver oil disagreeable, many products have appeared on the market which have achieved amazing success in disguising its taste. Many cod-liver-oil malts, having high potency in both vitamins A and D, are delicious. The oil itself has been flavored, often with peppermint or orange syrups, in such a way as to be palatable.

Many people who wish to maintain their present weight or to reduce must avoid the extra calories supplied by malts or oil. They should use capsules of halibut-liver oil, halibut-liver oil with viosterol, and concentrates of cod-liver oil. One capsule daily usually supplies the minimum requirement of both vitamins A and D. Each capsule contains approximately 5 calories. Since there are 4000 calories in a pound of fat, 800 such capsules must be taken before a pound can be gained from them. The popular idea that they are fattening is unjustified.

Halibut-liver oil, halibut-liver oil with viosterol, and cod-liver-oil concentrates may all be purchased in liquid form. These are adjusted so that ten drops is usually the recommended dose. Such products have been used widely in feeding infants but the vitamin D is less well absorbed than that from the natural cod-liver oils. The following table gives

the approximate vitamin potency and calorie content of various preparations supplying vitamin D:

	USUAL DOSAGE	VITAMIN A	VITAMIN D	CALORIES
Cod-liver oil	1 tbsp.	6000	1360	100
Cod-liver-oil malt	1 tbsp.	18,000	1800	80
Vegetable oil with halibut-liver oil and viosterol[1]	1 tbsp.	13,600	1360	100
Halibut-liver oil, liquid	15 drops, or 1 gram	50,000	1000	9
Halibut-liver oil, with viosterol	15 drops, or 1 gram	50,000	10,000	9
Cod-liver-oil concentrate	15 drops, or 1 gram	51,000	5100	9
Halibut-liver-oil capsule	1	10,000	200	5
Halibut-liver-oil capsule, with viosterol	1	18,500	1700	5
Cod-liver-oil concentrate, in capsules	1	10,000	1000	5
Pure viosterol in oil	15 drops, or 1 gram	none	10,000	9

[1] When cod-liver oil is not available, a valuable substitute, which has approximately the same calorie value, vitamin content, and dilution of vitamins, may be prepared inexpensively at home by adding 2 teaspoonfuls (10 cubic centimeters) of halibut-liver oil with viosterol to a quart of vegetable salad oil. One tablespoonful daily usually supplies adequate vitamin D. Since the oil has no fishy taste, it may be taken in the form of salad dressing or used in seasoning vegetables.

When any form of fish-liver oil repeats (or is tasted afterward), it should be taken just before retiring. One cannot taste anything when asleep. There is certainly some form of vitamin D to suit every purse and palate. Therefore, the failure to supply this needed food requirement daily, especially during the growth period, is inexcusable.

The chemist's view of vitamin D. Vitamin D is not easily destroyed. It is not hurt by exposure to oxygen or by cooking. This stability is important, since vitamin-D milks are used for cooking, and vitamin-D breads are toasted.

Vitamin D is also unharmed by storage unless the oil becomes rancid. In this case acid develops which causes the oil gradually to lose its vitamin-D potency.

Though you need not try to remember long chemical names,

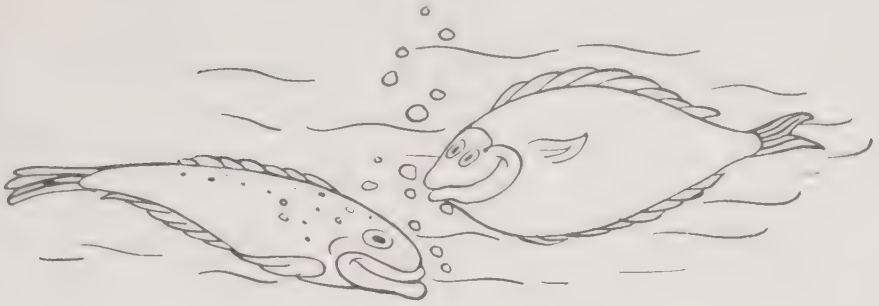
correct names of vitamins are appearing more and more in advertising material and in magazine articles on diet. It is therefore wise to be sufficiently familiar with them to know what they mean.

The provitamin D found in the vegetable kingdom is *ergosterol.* When irradiated, it forms *calciferol,* which is also called *vitamin* D_2. This product is diluted and sold commercially under the name of *viosterol.*

The vitamin D which comes from animal sources and is formed by the irradiation of the oils on skin, fur, wool, and feathers, is known as *dehydrocholesterol.* It is also called *vitamin* D_3. This form of vitamin D is found in all fish-liver oils, in eggs, and in cream, butter, and milk from cows fed fish-liver oil or irradiated yeast.

Absorption and excretion of vitamin D. Like fats and substances dissolved in fats, vitamin D is not well absorbed into the blood unless bile is present. Bile appears to be necessary for the retention of vitamin D in the body. When bile is prevented from flowing into the intestine of experimental animals, all the vitamin D in the body is rapidly excreted, most of it within a week.

Vitamin D is best absorbed when in diluted form. The vitamin D in vitamin-D milk, which has 400 units distributed in a quart of fluid, is most efficiently absorbed. The amount of vitamin which reaches the blood when 1200 units are distributed in a tablespoonful of cod-liver oil is also well absorbed, as are the vitamins from halibut-liver oil and viosterol, diluted with vegetable oil. On the other hand, when a baby is given the same number of units in ten drops of oil, very little is absorbed, and the child may develop severe rickets. Vitamin D is normally excreted by way of the large intestine. When larger amounts of vitamin D are taken than are needed, the excess is also thrown off.



Of much to humanity we are the givers,
For vitamin D is found in our livers.

Storage of vitamin D. Since vitamin D is soluble in fat, the body can store it and does retain a reserve whenever possible. Yet, even when generous amounts of vitamin D are given, the body appears to store this vitamin to a much smaller extent than it stores vitamin A. The amount stored depends on the supply in the diet and the length of exposure to sunshine or other ultraviolet light. When no vitamin D is obtained from food or sunshine, the stored supply is used. The use of the reserve is influenced by the amount of calcium and phosphorus in the diet. When these minerals are generously supplied, little vitamin D is called on. On the other hand, if the diet is inadequate in calcium and phosphorus, the supply of stored vitamin D is used and more quickly exhausted.

When generous amounts of vitamin D are given animals, the excess supply is stored in the brain, skin, kidneys, and liver. When no vitamin D is given, these stores are used first. The liver retains the vitamin as long as possible. It appears that the liver governs the amount of vitamin D allowed the body, and rations it out when and as it is most needed. Certainly the wise person sees that his body has a slight storage of vitamin D at all times. In its absence no definite disease will occur, except in infants, but full health, at any age, can probably never be obtained without this vitamin.

Projects

1. Go on an inspection trip through a dairy and see how milk is irradiated.
2. Go to the market to find how many foods state the vitamin-D content on the label. Inspect fresh milk, canned milks, butter substitutes, breads, and cereals. Is the amount enough to be significant? Is there an extra charge for the vitamin-D content?
3. Get prices of various forms of vitamin-D products from a druggist. Which supply the most vitamins A and D for the money?

Topics for Discussion

1. Why is milk the best food to be fortified with vitamin D? Is the cost of this milk greater than that of ordinary milk? If the cost is higher, is the vitamin-D milk worth buying? Give reasons for your answer.
2. Why should the use of viosterol alone be left to a physician's recommendations? What form of vitamin D should be used by a person wishing to reduce? by one wishing to gain? What form of this vitamin should be given to a baby?

Chapter 24

YOUR REQUIREMENTS OF VITAMIN D

A great deal of information has been accumulated concerning the minimum requirements of vitamin D. On the other hand, practically nothing is known of the ideal amounts of the vitamin needed to promote perfect health.

Vitamin D is the one vitamin thus far found to be toxic when given in excessive amounts. Though more than minimum requirements will undoubtedly be found to be needed for full health, care must be taken to prevent overdosage.

Too much vitamin D. If ergosterol is irradiated too long, a slightly poisonous substance is formed. This fact was not realized when the product was first put on the market, and some unfavorable results came from the use of irradiated ergosterol. Toxicity has rarely been produced by overdosage of any form of vitamin D except irradiated ergosterol.

Since this product, sold under the name of viosterol, or calciferol, is extremely potent, it should be used only on the advice of a physician. However, viosterol added to halibut-liver oil may be used with absolute safety.

The symptoms of excessive vitamin D are loss of appetite, nausea, headache, and diarrhea. The amount of calcium and phosphorus in the blood becomes abnormally high. (See page 230.) Large amounts of these minerals are thrown off in the urine. In severe cases, calcium is laid down in the soft tissues.

Toxic symptoms may occur when more than 400,000 units daily are given to the adult. Continued daily doses of 30,000 units are toxic to babies, and 50,000 units to children. Rarely are

more than 2000 units of vitamin D included in a daily dose. On the other hand, in the treatment of certain diseases physicians have given 200,000 to 1,000,000 units of vitamin D daily. There is a wide difference between the amount needed to prevent vitamin-D deficiency and that which may cause harm. Little likelihood exists that the informed person will err on the side of taking too much.

Babies' vitamin-D requirement. The amount of vitamin D needed by babies depends on the rate of growth, the type of vitamin given, and the amount of direct sunlight the child receives. Rapidly growing infants need larger amounts of vitamin D than do the slow-growing babies. For example, a child who grows slowly may be prevented from developing rickets by the amount of vitamin in vitamin-D milk. Rapidly growing children need large quantities of the vitamin.

The dilution in which the vitamin is given has proved to be of great importance. It was found that when the same number of units of vitamin D are given infants in the forms of vitamin-D milk, cod-liver oil, viosterol, and concentrates of fish-liver oils, babies are protected by milk and cod-liver oil, but not by the concentrates. Many babies given concentrates developed rickets. If concentrates are used, the disease can usually be prevented by giving 2000 to 3000 units daily.

It is better to give cod-liver oil directly rather than to add it to the baby's feeding, because the oil adheres to the bottle and the infant may obtain so little as to develop severe rickets. If this oil is given just before the bath, the child will not smell like a fish.

Babies fed on mother's milk develop rickets without added vitamin D as quickly as do bottle-fed babies. The vitamin-D content of human milk can be increased if the mother takes frequent sunbaths or some form of fish-liver oil. Though the

amount thus added is advantageous to the baby, it is not enough to prevent rickets.

The minimum amount of vitamin D needed to protect a normal infant against rickets appears to be about 800 units daily, provided it is given in the form of vitamin-D milk and cod-liver oil. Since the ideal amount of each body requirement is somewhat higher than that barely needed to prevent disease, it is probable that larger amounts of vitamin D are desirable, but the exact amount is not known. In a study of over 1000 infants given from 2000 to 9000 units of vitamin D daily in the form of viosterol, the growth was less than in babies given 1200 units in liquid cod-liver oil. It is not known whether the inferior growth was caused by giving too much vitamin D, or too little vitamin A, or because too little vitamin D in this concentrated form reached the blood. It seems wisest to give the bottle-fed baby vitamin-D milk. Ideally all babies should have a tablespoonful of cod-liver oil supplying 400 units per teaspoonful. There is a popular idea that cod-liver oil is difficult to digest. On the contrary, it is easily digested and offers the infant needed calories aside from the vitamins it contains.

Cod-liver oil or some other reliable source of vitamin D, as cod-liver-oil concentrate, should be started the first week of life. Never should it be delayed longer than two weeks. At first, only half a teaspoonful of cod-liver oil or 5 drops of concentrate need be given. This amount should be increased in two or three days to one teaspoonful of oil or 10 drops of concentrate. By the time the child is two months old, it should be given an entire tablespoonful of cod-liver oil daily. It is of extreme importance to know the requirements of vitamin D and continue the use of this vitamin indefinitely.

Vitamin-D requirements during childhood. The diet of a baby is usually adequate in calcium and phosphorus, but the

diet of growing children is frequently inadequate in these minerals. Since one function of vitamin D is to aid in the efficient absorption of calcium and phosphorus, it is extremely important that this vitamin be continued daily to help overcome the danger of a deficient mineral supply. No amount of vitamin D can make up for a lack of either calcium or phosphorus. Even when generously supplied, it can only prevent waste of the minerals eaten. It can never substitute for their lack.

As a child grows older, it seems to be able to absorb calcium and phosphorus somewhat more efficiently even in the absence of vitamin D. Children also absorb vitamin D in the form of concentrates much better than do infants. Throughout the growth period much calcium and phosphorus are lost via the large intestine, unless vitamin D is received daily. If the diet is adequate in these minerals, as when a quart of milk is taken daily, from 1500 to 2000 units of vitamin D is thought to be sufficient for normal bone and tooth development. When fewer minerals are included in the diet, more vitamin D is needed. The amount required is in indirect proportion to the calcium and phosphorus supplied.

In studies made in orphanages, varying amounts of vitamin D have been given to the children and the number of cavities in the teeth noted. There was little or no decrease in the number of cavities until from 600 to 800 units of vitamin D were given daily. Such an amount is probably the minimum requirement.

During adolescence, there is a spurt of growth during which the bones lengthen rapidly and require large amounts of minerals. It is especially important that vitamin D be amply supplied at this time in order that all minerals may be absorbed and retained. Unless the diet is exceptionally high in vitamin D, calcium and phosphorus are taken from the teeth and laid down in the bones. This exchange takes place because the

teeth are growing slowly at this time as compared with the bones. As a result, the teeth are likely to be ruined. The exact amount of vitamin D needed for rapid adolescent growth is not known. It is probably safe to say that no less than 2000 units daily should be taken.

Most of the fish-liver-oil preparations are adjusted to about 1000 units of vitamin D per dose or capsule. The person who wishes to save money on dental bills is well repaid for the small expense of some reliable source of vitamin D.

Requirements for adults. The statement is frequently made that there is no proof that adults need vitamin D. It is true that adults, given adequate amounts of calcium and phosphorus in their diets, absorb these minerals without vitamin D. The fact that middle-aged and older people do develop adult rickets, which may be corrected by cod-liver oil only, indicates that the vitamin is an advantage at any age.

Very few older people have had the advantage of a scientific education. They know little of the needs of their bodies. Often their diets are extremely low in the minerals, especially in calcium, because frequently they dislike milk or feel that it causes gas, and they believe cheese to be constipating. Their phosphorus intake is less likely to be inadequate, but it is still haphazard. Since vitamin D aids in efficiently absorbing these minerals from the diet, the less carefully the diet is chosen, the more the vitamin is needed to prevent waste of the meager supply.

Dr. Steenbock of the University of Wisconsin carried on experiments with older rats kept on rickets-producing diets inadequate in minerals. The rats without vitamin D lost large amounts of calcium and phosphorus from their bones. Those given this vitamin, even though fed the same diet, lost far fewer minerals. The fragility of the bones of older people today is a matter of common knowledge. Though lack of minerals is

largely responsible for this fragility, vitamin D can aid in the prevention of such a loss.

Studies with people over 60 by means of X-ray have shown that bones may be mineralized by a diet adequate in calcium, phosphorus, and vitamin D. It must be remembered that hundreds of thousands of adults, even people as young as twenty and thirty, are unable to get into the sunshine daily during the summer months.

The amount of vitamin D desirable for an adult is not known. Outstanding authorities have suggested 800 units per day. This small amount may be obtained from two teaspoonfuls of cod-liver oil or one capsule of fish-liver-oil concentrate. Whatever the source, it should be obtained daily by every adult throughout the winter months and even during the summer by those who cannot take sunbaths daily.

Case Histories

R. A., a mother, gave cod-liver oil daily to her beautiful child of three. A second baby was given only ten drops of halibut-liver oil, which contained about 135 units of vitamin D. Not only was the amount too low, but there was doubt whether the vitamin was absorbed in this concentrated form. When the second child was a year old, only two teeth had come in and they were protruding and overlapping. Its forehead was prominent and overhanging. Its legs were badly bowed, despite the fact that it had made no attempt to walk. The child was extremely ugly and will probably remain so throughout life. Yet, a little knowledge on the part of the mother of vitamin-D requirements could have allowed the baby to be a normal, lovely child.

O. M., an 11 year old boy, was a homely child with narrow, underdeveloped facial bones. His jaws were so small that his teeth were crowded together, crooked, and overlapping. His mother had taken him to three dentists, who had estimated the cost for straightening his teeth to be $800, $1200, and $1500 respectively.

Since the family's income was small, to pay such prices was out of the question.

A physician at the Health Clinic explained that vitamin D helps bones to develop normally, and suggested that the boy be given a capsule supplying 50,000 units of this vitamin every Sunday for three years. Since the vitamin is stored, the one capsule each week would furnish 7,100 units daily. He explained that if the added vitamin D did not cause the jaw bones to develop sufficiently for the teeth to straighten, there would be time for mechanical straightening later.

The advice was followed faithfully. After three years, when the boy was 14, his teeth were straight and in perfect alignment. The pressure of his tongue on the inside and of his cheeks and lips on the outside had pushed his teeth into line as his jaw bones had grown large enough to allow space for each tooth. His entire face had widened, and he had changed to an attractive, handsome boy. Yet the cost of the treatment had been only $3.

Project

1. Calculate the units of vitamin D you have obtained from foods eaten in twenty-four hours. How does your intake compare with your requirements?

Topics for Discussion

1. What are the symptoms of overdosage of vitamin D?
2. Why do many infants still have mild rickets when most of them receive some form of vitamin D? Why do some infants need more vitamin D than others?
3. Why is it so extremely important to give growing children vitamin D? Why does the vitamin-D requirement vary in relation to other body requirements?
4. Why should adults always obtain some form of vitamin D?

Chapter 25

OTHER VITAMINS

There is no doubt but that other vitamins exist. Many may be of great importance to health. At present, there is evidence based on animal experiments of the existence of vitamins which are tentatively named: I, J, L_1, L_2, M, U, W, and several others. The value of each of these to human health is unknown. There are, however, three more vitamins, the chemical nature of which is known.

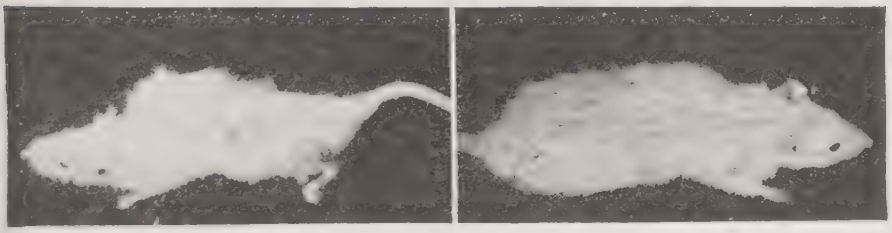
Vitamin-E. This vitamin was first discovered by Dr. Evans and Dr. Bishop at the University of California. Experimental diets accidentally included rancid lard. It was later learned that rancidity of fats very quickly destroys vitamin E.

These doctors found that male rats on such a diet produced no offspring. Therefore, it was proved that vitamin E is associated with the reproductive process.

When young animals are placed on a diet lacking vitamin E, they appear to grow normally and to be healthy up to the time when they almost reach maturity. At that time, they grow less than do the animals which are supplied with the vitamin. Besides their inability to reproduce, animals kept on a diet low in vitamin E throughout life develop a stiffness of their legs and a curious baldness.

Sources of vitamin E. Wheat germ is the richest natural source of vitamin E likely to be included in the daily diet. Since the vitamin is soluble in fat, it is in the oil of the wheat germ which can be separated to give a concentrated source of the vitamin.

Vitamin E is also found in cottonseed oil, corn oil, sesame-seed oil, soybean oil, and peanut oil. It occurs in lettuce, tomatoes, carrots, egg yolks, and nuts. Alfalfa seems to be the most reliable source for farm animals. The germ of all cereals, such as oats, corn, rye, and barley, contains vitamin E; therefore the vitamin is in all whole-grain breads and cereals. Lard substitutes made of vegetable oils are excellent sources. Meats are sometimes a good source, but the vitamin-E content depends on the diet of the animal from which it comes.



The rat, at the left, for one year has been fed a diet adequate in all respects except for vitamin E. The rat at the right is a littermate of the rat deficient in vitamin E, but has been fed a normal, complete diet.

Vitamin E appears to be absent from yeast, animal lard, cod-liver oil, and castor oil. Polished rice, refined cornmeal, and white flour lack it. Butter and cream are usually low or lacking in vitamin E.

This vitamin is not harmed by cooking, storage, or contact with oxygen. When the fat associated with it becomes rancid, it is destroyed very quickly.

Vitamin E is soluble in fat. For this reason it is readily stored in the body when an excess is taken. It is stored so efficiently that in feeding animals, it need be given only once a year.

The scientific name for this vitamin is alpha tocopherol. The vitamin is made chemically and is sold in capsules having a hundred times the potency of pure wheat-germ oil.

Relation to vitamin A. It has been found that when night blindness exists, a certain amount of vitamin A is needed to

restore normal vision. If vitamin E is generously supplied, far less vitamin A is required. Similarly, any deficiency of vitamin A is more quickly overcome when vitamin E is increased in the diet. The more vitamin E obtained, the less vitamain A needed. The vitamin-A sparing action of vitamin E is not yet understood but is undoubtedly an important one.

Animal needs for vitamin E. Vitamin E may be of practical value in raising farm animals. It is known that hens, fed a diet lacking the vitamin, lay eggs which fail to hatch. If the hens are given an undersupply, the baby chicks appear to develop normally during the first three days but die on the fourth or fifth day. Addition of ample vitamin E to the hens' diet causes the eggs to hatch and the chicks to be healthy.

When rich sources of vitamin E have been added to the diets of female goats, sheep, rabbits, cattle, and pigs which have failed to reproduce, they have given birth to normal young. The *oil* of wheat germ is usually used.

The function of vitamin E. It has been found that rats given generous amounts of vitamin E are resistant to cancers, which can be readily produced in animals receiving less of the vitamin. Also it has been shown that cancer tissue, placed in blood serum rich in vitamin E, will not grow, though that in serum lacking vitamin E will grow readily. It is thought that in the presence of vitamin E, cells divide normally; in its absence healthy cell division cannot take place, and thus cancer cells are allowed to grow. It is known that cancer occurs at a point of friction such as the lip of a pipe smoker, or a kidney or gall bladder irritated with stones. Friction causes the destruction of tissue, and new growth, or cell division, must continuously take place to keep the tissue in healthy repair. New growth apparently requires vitamin E. Whether this vitamin has any relation to building resistance to cancer in humans is not known.

If mineral oil is used as a laxative, vitamin E from the food in the intestinal tract dissolves in it and is thus prevented from reaching the blood stream. Cancer has been produced in rats by feeding mineral oil, probably because their bodies were depleted of vitamin E. Again, what bearing this finding has on human nutrition is not known. Certainly it would seem unwise to use mineral oil internally.

Vitamin E is lost when grains are refined. The tremendous increase in cancer since the milling of grains began may have some relation to this vitamin loss.

The wise procedure. Until more is known about the need of vitamin E, its relation to growth, action on nerve and muscle, and its possible relation to cancer resistance, let us play safe and see that it is included daily in the diet. The use of wheat germ, 100 per cent whole-grain breads or wheat-germ breads, peanut-butter sandwiches instead of those made of jam or jelly, and nuts as a candy substitute, promotes health in many other ways besides supplying vitamin E.

Vitamin K. Vitamin K is necessary before blood can clot or coagulate. Nature has provided intricate steps to bring about the clotting of blood.

There is a substance in the blood known as *fibrinogen* which can change to *fibrin*. As the name implies, fibrin is a fibery, cobweb-like structure which holds the clot together. This change from fibrinogen to fibrin is brought about by the action of an enzyme known as *thrombin*. If blood were to clot in the blood vessels, death would immediately result. Therefore, this enzyme can exist only in an inactive state. The inactive enzyme is spoken of as *prothrombin*.

Prothrombin is produced by the liver. It cannot be produced, however, unless vitamin K is present. The speed with which clotting takes place has been found to be directly proportional to the amount of prothrombin in the blood. When

tissues are mashed, cut, or injured in any way, a substance is freed which immediately causes prothrombin to react with calcium in the blood, changing prothrombin into the active enzyme which brings about clotting.

Discovery of vitamin K. It was found that when fowls were kept on purified diets, fatal hemorrhages frequently resulted. In experiments in which bile was prevented from flowing into the intestinal tracts of mammals, hemorrhages caused death. The addition of certain foods to the fowls' diet and the normalizing of the flow of bile in mammals were found to prevent or correct the hemorrhages. Vitamin K was isolated from these foods and given its name by a Danish scientist. Pure vitamin K is now made in the chemist's laboratory.

Source and absorption of vitamin K. The richest sources of vitamin K are green leaves, alfalfa, spinach and kale. Carrot tops are particularly rich in this vitamin. Although many foods have not been tested, this vitamin appears to be widespread.

Vitamin K, like A, D, and E, readily dissolves in fat. It is found associated with fats in foods and is freed in the intestinal tract as fats are digested. Like fat, it cannot pass through the intestinal wall unless carried by substances in bile, known as bile salts. Since vitamin K is widespread in foods, it appears to be deficient in adults mainly in cases where the flow of bile is abnormal.

Occasionally stones from the gall bladder lodge in the tiny canal leading from the liver to the small intestine, closing the canal and preventing the flow of bile. Sometimes the bile duct is infected and swells enough to close off the canal. In cases where jaundice results, vitamin K cannot be absorbed into the blood, prothrombin cannot be produced, and the blood fails to clot. Often surgery must be resorted to in cases where the bile duct is closed. In the past as many as 50 per cent of the people

who were operated on for this condition died of hemorrhage because the blood could not clot. Now that vitamin K is known, such patients are given this vitamin, together with bile salts, and the clotting of blood becomes normal within a few hours. Babies are born with a very limited supply of vitamin K. As a result, hemorrhage in the new-born is frequent and is responsible for a large number of the deaths which do occur at birth. Brain hemorrhage often results in lifelong abnormalities such as spastic paralysis, in which muscular movements are jerky and unco-ordinated. Alert physicians now give babies pure vitamin K during the first hour of life.

Fulfilling your vitamin-K needs. The most obvious vitamin-K deficiencies are those which have already been discussed. The vitamin is new, however, and very little is known of possible subtle deficiencies which we may all experience at one time or another. Recent studies show that vitamin-K deficiency exists during many different types of infections such as those of the tonsils and sinuses. Deficiencies also exist in persons who show evidence of general malnutrition; therefore, for the person who is undernourished, at any time during infections and particularly before any type of surgery, the intake of green leafy vegetables should be definitely increased. Since vitamin K is not harmed by heat or oxygen, these can be used either cooked or raw, as in salads.

The deficiencies of vitamin K which are now recognized are rare, but since the deficiency is often fatal, it is all the more important to make sure your intake of this vitamin is generous.

Citrin. Citrin, formerly called *vitamin P,* also has to do with the prevention of hemorrhage, but in an entirely different way from vitamin K. When citrin is lacking, the walls of the blood vessels become porous. Red corpuscles can then pass through the walls into the tissues.

Vitamin P was named in honor of *paprika,* from which it

was first extracted. It appears to be richly supplied in various types of peppers, in citrus juices, and particularly in lemon peel. Like vitamin A and riboflavin, it is yellow in color.

By her eyes he's tantalized.
It's because she's vitamized.

Citrin dissolves easily in water and is lost if foods containing it are soaked or cooked in water and the water discarded. It can be obtained, however, by soaking these foods in water and drinking the water, as in making lemonade to which the lemon peel is added.

Advantages of natural foods. As long as natural foods are used, one is reasonably sure of getting at least some of all of the vitamins, both known and unknown, and of all the minerals. The life processes of the cells in every living tissue, whether in plants or in animals, depend on the presence of minerals and vitamins just as do the cells of the human body. When foods are refined, the vitamins and minerals are largely discarded.

A great deal has been said about including a variety of foods in the diet. It is true that one food is often richer than another in certain body requirements; therefore, by using a large variety of fruits, vegetables, and different grain products, one is more likely to get all of the substances necessary for health, including those still unknown. There is no argument for variety, however, if, in order to obtain that variety, foods which can make no contribution to health are included.

Projects

1. List all foods you have eaten in twenty-four hours which contain vitamin E. Are any of them rich sources of this vitamin?
2. Check the foods you have eaten during twenty-four hours for sources of vitamins K and citrin.

Topics for Discussion

1. When should greatest care be taken to obtain vitamin K? What is its function?
2. What occurs when citrin is inadequate? When would especially large amounts need to be given?
3. What are the advantages of: eating only unrefined foods; of obtaining a varied diet? When is variation often overemphasized?
4. What are the sources of vitamin E? If more vitamin E is desired, what cooking fats would be well to use? Why is the intake of the vitamin less now than one hundred years ago? Give two reasons.
5. What appears to be the function of vitamin E? When would the body requirements be highest? How could the use of mineral oil be harmful?

PART THREE

WHAT MINERALS CAN DO FOR YOU

Chapter 26

WHY YOU NEED CALCIUM

The body of an adult contains 3 or 4 pounds of calcium, 99 per cent of which is found in the teeth and bones. It is not surprising then that the development of the skeleton is roughly in proportion to the amount of calcium received daily during the growth period.

Calcium and stature. The tallest peoples in the world are those who have eaten the largest amount of calcium-rich foods. In prosperous peacetime, the daily food of the Finns, Scandinavians, and Bulgarians has been found to contain as much as 4 grams of calcium, or about eight times the average intake of an American. These people are notably tall.

Oriental races live on calcium-poor diets. These people are usually short. Second-generation Chinese and Japanese children, born and brought up in America where the calcium intake is higher, grow an average of 3 or 4 inches taller than their parents. The same is true of the American-born children of Russian-Jewish immigrants.

As the diets have improved throughout the years, people have become not only taller but bigger boned. The chest measurements have increased, and bones throughout the body are correspondingly larger. Greater development today is evident if one inspects the armor left from the days of the Crusaders. Nowadays only a man of medium build can manage to squeeze into the average coat of mail.

Calcium and skeletal development of animals. Animals are always limited in growth by low-calcium intakes, just as people

are. Experimental animals which are fed identical diets except for the calcium, will grow in proportion to the calcium content of the diet. The bones of those which are given limited amounts are often only half as large as those on adequate diets.

An interesting example of this fact occurred when Shetland ponies, grown on the calcium-deficient grasses of the Shetland Islands, were brought to America and pastured on the calcium-rich forage of Long Island. After a few generations, their skeletal structure was so changed that they could no longer be recognized as Shetland ponies.

Recognizing calcium deficiencies. Although only 1 per cent of the calcium in the body is found in the nerves and soft tissues, this small amount is of tremendous importance. If the diet is moderately inadequate in calcium, X-rays show that the bones become rarefied before stunting of growth takes place. A lack of calcium is usually unsuspected, because it gives little outward evidence aside from perhaps tooth decay.

It is in the definite changes shown by the soft tissues that we must recognize and interpret warnings that the calcium supply should be increased. By close observation of these signs, a diet inadequate in calcium may be detected before it advances to the stage when the bones are rarefied, or growth is actually stunted.

Calcium and nervousness. Calcium is used by the nerves in the transportation of impulses. When calcium is undersupplied, nerves become tense and irritable. Irritable nerves, or nervousness, can also be caused by other deficiencies, but lack of calcium is a major cause.

In children we see nervousness indicated by temper tantrums, unpleasant dispositions, chewing of fingernails, and restlessness in sleeping. Nervous children cry easily. The calcium-deficient adult is inclined to be quick tempered, grouchy, and irritable, and to have a feeling of tenseness or uneasiness.

He will often exhibit restless habits such as tapping the arm of a chair or swinging his feet. He usually can neither relax nor sit quietly. Frequently he has difficulty in getting to sleep.

His nerves cry aloud, "Give me calcium please!"
To make him relax, give him good milk and cheese.

Hundreds of thousands of dollars are spent each year by such persons for self-prescribed, harmful sleeping powders and tablets. Since milk is our richest source of calcium, warm milk drinks, taken before retiring, have logically long been advocated. The heat quickens digestion, the calcium soothes the nerves, and restful sleep usually follows.

Calcium and muscle changes. A lack of calcium also causes irritable muscle tissue. In a certain type of rickets, the calcium in the tissues may become so low that severe convulsions occur. Years ago, when rickets was common, one frequently heard of babies having fits. These fits were in reality caused by low blood calcium due to the lack of vitamin D. Because of better infant feeding, such convulsions rarely occur today, but irritable muscle, in milder forms, is not unusual.

Cramps of all types are associated with lack of calcium. They often occur in rapidly growing children whose bones are

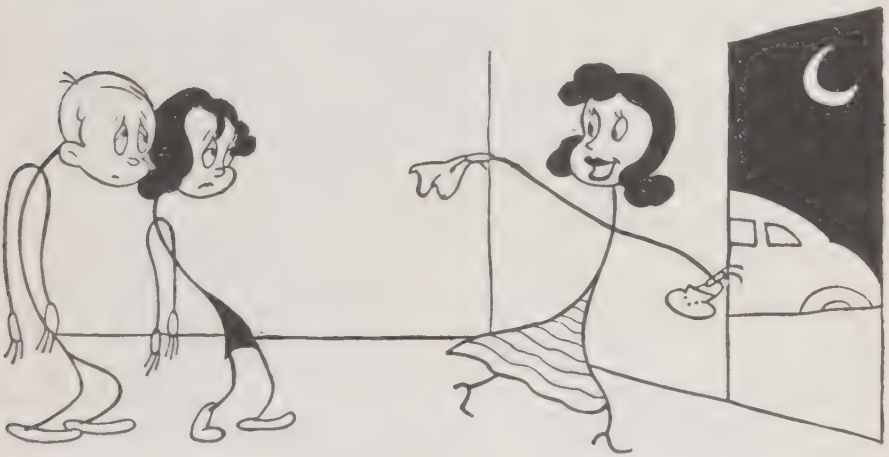
Vitality for normal activities.

demanding large supplies of minerals. The cramps generally come in the leg muscles but may also be noticed in other parts of the body. In girls and women, they are most frequently noticed in the abdomen.

Calcium is extremely important in regulating the action of the heart muscles. Throughout the entire life span the heart must contract and relax about seventy-two times each minute. A living heart can be removed from an animal's body, and if kept in fluid which supplies all the minerals contained in the blood, will remain beating for some time. When certain minerals are absent, the contraction, or irritability, of the heart muscle, which causes it to beat, does not take place. But, in the absence of calcium, the heart cannot relax. Calcium is, therefore, necessary to keep the heart rested, and especial attention

must be given to eating calcium-containing foods in cases where the pulse is too rapid.

Calcium and posture. Calcium is also needed to give *tonus* to the muscles. Tonus means the normal contraction of muscle which maintains it in immediate readiness for action. Muscles of good tone have the pull of strong rubber even when relaxed; those of poor tone are stringy and flabby.



People who droop like a weak question mark
Rarely are asked to go out after dark.

Deficiency of almost any one of the body requirements results in poor muscle tone. Poor tone appears to be an outstanding characteristic in the disease of rickets. Lack of muscle tone is responsible for the protruding stomach, the head carried forward, and the rounded shoulders always associated with rickets and seen in almost anyone with poor posture. Such a child will tense his muscles temporarily when told to stand straight, but his muscles lack the pull necessary to keep him standing correctly.

Often mothers tell their children to stand straight, when the muscle tone is not sufficient to hold the body in an erect position. The poor diet prepared by the mother herself is really

responsible. Any nutrition worker has seen children whose posture has been poor, begin to stand normally as soon as the diet had been improved and the muscles had become strong. In any case of poor posture caused by weak muscles, the amount of vitamin D, calcium, and phosphorus should be checked and made ample before the child may be expected to stand erect.

Perhaps the outstanding example of the relation of calcium to posture is that of a boy sixteen or seventeen years old, who has suddenly grown several inches. The lengthening bones steal the available calcium supply, and little is left for the soft tissues. Unless the diet is unusually good, his muscles are flabby, his posture is poor, and he is often awkward to the point of self-consciousness.

Calcium and blood clotting. Calcium is also necessary for the clotting or coagulating of blood. The person who bleeds profusely after a minor scratch is usually not getting an optimum quota of calcium. Lack of calcium in this respect may be extremely serious. Coagulation of the blood may be a matter of life and death at the time of an accident. The wise dentist or physician, whenever possible, forewarns his patient to eat a diet especially rich in calcium before even minor surgery.

Calcium and tooth decay. A partial lack of calcium results in poorly developed or decayed teeth, depending upon the age when the lack occurs. The changes in the teeth are the same as those found when vitamin D is lacking. Too little vitamin D allows calcium to be lost by way of the large intestine. The effect is therefore the same as a direct lack of calcium. Even though the diet during growth is abundantly supplied with this vitamin, the teeth fail to develop properly if there is a deficiency in calcium. Under these conditions, they become decalcified and are susceptible to decay during growth and in adult life.

The lack of calcium also leads to the removal of minerals

from the jaw bones. This loss of minerals is a problem with older people, for it exaggerates cases of pyorrhea and often causes the loss of teeth and also difficulty in keeping false teeth in place.

Absorption of calcium. Absorption of food is a factor so important in nutrition that it cannot be overemphasized. To see that there is a supply of calcium in the diet is not enough. The calcium must pass through the intestinal wall and into the blood stream before it can be of value.

Calcium from foods which have been eaten is dissolved by the hydrochloric acid during digestion. The continuous passage into the small intestine of acid and acid-food mixtures from the stomach keeps the calcium in solution until it passes into the blood. In the same way, acid aids the absorption of many other minerals, such as phosphorus, magnesium, and iron.

In the absence of acid in the stomach, calcium remains insoluble and never reaches the blood, even though the supply in the food may be generous. In a vitamin-B-complex deficiency, the flow of acid in the stomach is either greatly decreased or perhaps entirely absent. The widespread lack of the B vitamins does untold harm in terms of decayed teeth, poor posture, stunted skeletal development, and other abnormalities resulting from poor absorption of the calcium actually eaten.

Influences on calcium absorption. Since surveys showed that 90 per cent of the milk sold in school cafeterias was chocolate milk, studies were undertaken to determine its value. Compared with animals given the identical diet except for plain milk, animals fed chocolate milk absorbed less calcium and phosphorus. Their growth was retarded and their bones were small and fragile. Both chocolate and cocoa interfere with the absorption of calcium to such an extent that it is valueless to

attempt to obtain this mineral by drinking cocoa and chocolate milk, malts, and milk shakes.

The calcium from plain milk and cheese is more completely absorbed than from any other foods. The calcium from bones is also easily absorbed. Carrots, kale, and almonds contain calcium in small quantities but in a form which is well absorbed. The calcium in spinach is not well absorbed, if at all. Spinach contains a substance, oxalic acid, which combines with calcium to form an insoluble salt. This fact must not be interpreted to mean that spinach should be avoided. It should, however, never be depended upon to supply calcium.

It is known that vitamin D is essential for the absorption and the utilization of calcium and phosphorus. When vitamin D is supplied, the contents of the large intestine are acid and thus favorable to the passage of minerals into the blood. In the absence of vitamin D, the contents are alkaline, and large quantities of minerals are lost from the body.

The presence of carbohydrates in the intestine stimulates the flow of the alkaline digestive juices. When candies and other concentrated sweets are eaten together with calcium-containing foods, these alkaline juices pour out rapidly and change the fluid from acid to alkaline before the calcium can pass into the blood; hence calcium becomes insoluble, and much of it is lost from the body. This interference with calcium absorption is thought to be one reason why sweets are so destructive to the teeth.

Calcium balance. Regardless of whether or not you eat foods containing calcium each day, this mineral is continuously lost from your body, principally by way of the large intestine. The calcium which is lost might be thought of as worn-out calcium.

If all the calcium in the food eaten on a given day is accurately measured and compared with that lost in the urine and

feces on that day, it may be determined whether the body is storing or losing calcium. When the amount eaten is greater than that lost, and some can be reserved for growth or storage, the body is said to be in *positive calcium balance*. Should the amount lost exceed that eaten, a *negative calcium balance* exists. If the amount eaten is identical with the loss, the body is said to be in *calcium equilibrium*.

Children, from birth throughout the entire growth period, should eat enough calcium-containing foods daily to allow an excess over the amount lost from the body. This excess is needed in order that the bones may enlarge and lengthen. Every child should be in a continuous positive calcium balance.

Under normal conditions, an adult can maintain his health by eating just enough calcium each day to equal that which is lost. An excess, however, is desirable in order to allow for incomplete absorption. Never at any time throughout the life span is a negative calcium balance compatible with perfect health. Unfortunately, such a condition exists all too often.

Storage of calcium. You will notice that, when the end of a soup bone is cut lengthwise, the center part of the bone is filled with a lacy network of bony structure. The fibers in this network are called *trabeculae*. This part of the bone is the storehouse or the bank for any excess calcium and phosphorus not needed for immediate use. You may have seen that in some bones the center was hollow. The absence of trabeculae occurs when the diet of the animal has allowed no excess calcium for storage.

Many types of experiments have confirmed the finding that, if calcium is taken in excess to that needed for immediate use, it can be stored to great advantage, and this excess may be used at times when the diet is poor. For this reason a slight positive balance should be taken daily throughout life. Such experiments also show that when calcium is not supplied, the amount

stored is first called upon. When that supply is used up, the calcium and phosphorus are removed directly from the bones and dentine of the teeth, to supply the immediate needs of the body. Therefore, a stored supply of calcium is the only means of fully protecting the skeletal structures.

The tidal flow of calcium. It is easy to think of the bones and teeth as being lifeless structures, unchanging after growth is finished. Such an idea is far from the truth.

There are, on each side of the windpipe, two tiny glands called the *parathyroids*. These glands produce a hormone, or chemical messenger, whose work it is to maintain, as far as possible, an ideal amount of calcium in the blood at all times.

Let us suppose that you are careless about eating calcium-containing foods. When your heart needs calcium to help it relax, the parathyroid glands send their chemical messengers to the bones and ask them to give up calcium for the heart. On the other hand, if your bones are growing rapidly and need calcium to make them hard, and if no calcium-rich foods have been eaten, the parathyroids may ask the teeth or soft tissues to give up minerals for the bones.

So it is that, when calcium is furnished in the diet, the mineral coming in from the intestinal tract supplies the body needs. If the diet is not adequate, the mineral is removed from the bones and teeth. In this way, the amount of calcium in the blood stays practically the same throughout life. It is not until the bones and the teeth have been robbed as much as they can be, not until the teeth begin to decay, and x-ray pictures show the bones to be rarefied, that the amount of calcium in the blood drops below the normal level.

About one-half cup of blood (100 cc.) normally contains 11 milligrams of calcium. Should a chemist analyze the blood for calcium and find only 8 or 10 milligrams, it would be obvious that the diet had either supplied less than the body

needed or that the amount supplied had not been absorbed into the blood.

The bones and teeth, therefore, far from being lifeless and unchanging, are in reality changing every hour of the day and every minute of every hour. There is a continuous tidal flow. As calcium-rich foods are digested and absorbed into the blood, the tide flows into the bones. When the diet is neglected, the tide flows out. This continuous changing goes on as long as life itself.

Relation of calcium to phosphorus. Under normal conditions the amount of calcium in the blood is slightly more than twice that of phosphorus. In order that both minerals shall be in the blood in amounts needed to promote health, both must be liberally supplied in the diet.

Calcium and phosphorus are largely used in the body in chemical combination with each other. In this form they are laid down in bones and teeth. If one is lacking, there is nothing with which the other can combine; therefore, one without the other is of little value.

We have learned that in building bone, the phosphorus is first liberated by enzymes. This phosphorus then combines with calcium brought by the blood to form a calcium-phosphorus salt. Finally, so much of this salt is held in the fluid of the bone cell that it *settles out* or crystallizes, just as sugar crystallizes in a pitcher of thick syrup.

If the diet is poor in calcium but rich in phosphorus, there is too little calcium to combine with phosphorus. The concentration of calcium-phosphorus salt does not become great enough to settle out in the bones. The phosphorus therefore cannot be used, and much of it is excreted in the urine. Since there is always calcium in the blood, much of the excreted phosphorus is in the form of calcium-phosphorus salt. In this way, the body is robbed of its limited calcium supply, and, at

the same time, phosphorus is lost even though it may be greatly needed.

This loss is actually happening to millions of Americans. Meats, eggs, all foods made from grain, and most vegetables are excellent sources of phosphorus. Milk and cheese, both rich in phosphorus, are the only worthwhile sources of calcium. Consequently, the person who does not use dairy products almost always eats a diet high in phosphorus and low in calcium. The needed phosphorus is thrown off from the body and steals much of the already deficient calcium supply. By eating ordinary foods, you cannot possibly get a diet excessively high in calcium and yet low in phosphorus.

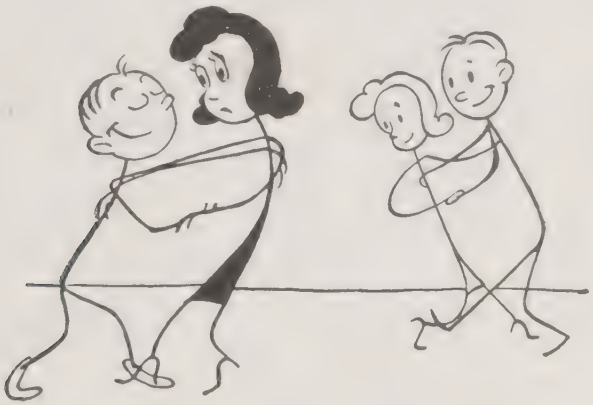
Calcium is needed to hold phosphorus in the body and to allow it to be used. When the amount of phosphorus does not exceed two times that of calcium, both minerals are well retained. This proportion is spoken of as the calcium-phosphorus ratio. If liberal quantities of milk and cheese are used, calcium is supplied, and no problem arises.

A deficiency of calcium can therefore be caused by a lack of calcium itself, by poor absorption of calcium into the blood, and by such a generous amount of phosphorus that calcium cannot be retained.

The need of vitamin D. Vitamin D is necessary in order that calcium and phosphorus may be used normally. It aids in the absorption of phosphorus and probably calcium. Vitamin D is also important in aiding the body to lay down these minerals in the bones and teeth. It may have some influence on the parathyroid glands.

Infants are particularly unable to absorb calcium and phosphorus if vitamin D is absent. As children grow older, there is an increase in the amount of calcium and phosphorus reaching the blood in the absence of vitamin D. However, at no time during life are these minerals efficiently absorbed without

vitamin D. The fact that vitamin D must never be looked upon as a substitute for calcium and phosphorus cannot be overstressed. An outstanding example is found in the children in Norwegian villages where livers of codfish are often used as food. Though the vitamin D is tremendously high, the almost total lack of calcium in the diet has caused these children to be stunted in growth.



For foods rich in calcium keep on the hunt,
They've saved many a boy from being a runt.

It must always be remembered that phosphorus and calcium and vitamin D are all dependent upon each other. Though it is not quite so necessary to eat generous amounts of calcium and phosphorus, if vitamin D is always obtained, as it is if vitamin D is lacking, none of the three can work efficiently without the other two.

Case History

Kenneth C. was a thin, irritable youngster of ten, whose fingernails were chewed to the quick. His muscles were as stringy as worn-out rubber bands. His mother was eager for the boy to impress her friends. If he were present when there were visitors, the conversation was interrupted every two minutes with a sharp, "Kenneth, stand up straight!" The child would tense his muscles

as best he could, although he was unable to stand erect for long. The youngster had little appetite and disliked milk and cheese. At a friend's suggestion, wheat germ and other foods rich in the vitamin-B complex were added to his diet. As his appetite increased, he ate larger amounts of calcium-rich foods.

Although the change was gradual, Kenneth gained weight and developed a pleasant disposition. The most striking improvement showed itself in his posture. He stood erect because his muscles held him so and not because he was asked to do so.

Projects

1. Obtain from the butcher some of the long bones from two or three animals. Have them cut lengthwise. Observe the presence or absence of trabeculae in the bones. Which animals apparently had a diet richer in minerals?
2. Into a glass containing vinegar or dilute hydrochloric acid, put 0.1 teaspoonful of a calcium salt, such as dicalcium phosphate, calcium gluconate, or calcium chloride, which may be obtained from the drug store. Add the same amount of calcium to a glass of water and also to a third glass of water which contains a half teaspoonful of baking soda. Notice that the calcium dissolves in the acid. Calcium is soluble in the body only in the presence of acid.
3. Feed two or more rats, one on a low calcium-phosphorus diet, the other on an adequate diet. After normal growth has taken place, ask the biology department to mount the skeletons for comparative study.

Topics for Discussion

1. What other deficiencies besides the lack of calcium can cause nervousness?
2. Since calcium is absorbed in the absence of vitamin D, why does the lack of calcium cause bone and teeth changes similar to changes due to lack of vitamin D alone? Why does a high-phosphorus low-calcium diet cause loss of calcium from the body? Give three reasons why Americans get less calcium than they need.

3. How can an inadequate calcium intake make for unpleasantness in the home? Is it possible that the person who is a poor sport may be so because of the food he eats? In observing the dispositions of your friends, can you note any differences which might indicate a lack of calcium?
4. Observe people around you and list all possible calcium deficiencies you have noted.
5. What is a positive calcium balance? A negative calcium balance? What is meant by calcium equilibrium?
6. During what years of life is a positive calcium balance essential to health? Could a positive calcium balance exist during the late years of life? Why? Is a negative calcium balance ever compatible with health? Is so, under what conditions?

Chapter 27

SOURCES AND REQUIREMENTS OF CALCIUM

Never is the statement, "You get everything you need if you eat a well-rounded diet," so untrue as when it refers to the calcium requirements. A diet may be delicious, abundant, even varied, and at the same time be extremely poor in calcium.

Calcium deficiency in America. The American diet offers only two dependable sources of calcium: milk and cheese. Of course there is calcium in buttermilk and any food prepared with milk or cheese. According to Dr. Sherman of Columbia University, the deficiency of calcium in this country is more widespread than that of any other mineral.

In a survey made in North Carolina, it was found that only 23 per cent of the children were drinking milk. According to the amount of milk sold in many cities, the average daily intake is less than a half pint per person per day. Rural families, however, use milk in somewhat larger amounts. The entire dairy industry in the United States produces only enough milk to supply each person with a pint daily, and much of this amount is made into cheese.

The average consumption of cheese per person per year in the United States is only 4 pounds. Contrast this consumption with the intake of refined sugar, 97 pounds per person per year. Such figures show why the government has become interested in undertaking a nation-wide nutrition program.

Our calcium sources. It is true that many other foods besides milk and cheese contain calcium. The following table lists the richest sources and shows the amounts of each food

(uncooked) which would supply the daily calcium requirement of 1 gram:

Almonds	40 (2 cups)	Figs, dried, medium	43
Apples, large	72	Flour, wheat	2¼ pounds (9 cups)
Artichoke, medium	50	Flour, white	14.5 lbs. (58 cups)
Asparagus stalks, green, 5 inches long	384	Flour, soybean	1 pound (4 cups)
Bananas, large	80	Kale	3 cups
Beans, navy (uncooked)	3⅓ cups	Leeks	8½ cups
Beans, string	14 cups	Lettuce, green leaves	145
Beef, lean	1 pound	Maple syrup	2 cups
Beets	18 cups	Milk, dry skim, powdered	½ cup
Bread, white, slices	129 (10 loaves)	Milk, evaporated (undiluted)	2 glasses
Broccoli	5½ cups	Milk, sweetened condensed	2 cups
Buttermilk	4 glasses	Milk, whole	1 quart
Cabbage, green	3½ cups	Molasses, blackstrap	¼ cup
Carrots	11 cups	Molasses, dark	1.2 cups
Celery, 6-inch stalks	51	Mustard greens	1 cup
Chard	5 cups	Okra	7 cups
Cheese, American	2½ cubes (2″x1″x1″)	Oranges, medium	42
Cheese, cottage	2 cups	Parsnips	8⅓ cups
Cheese, cream	1 cup	Potatoes, white, medium	77
Cherries, 30 per cup	21 cups	Turnips	9 cups
Clams	66	Turnip tops	1½ cups
Collards	2½ cups	Watercress	5 cups
Dandelion greens	9 cups		
Dates, dried, medium	214		
Eggs, medium	33		
Endive, stalks	96		
Escarole	26 cups		

Study the table carefully and see if you eat enough of any of these foods, except milk and cheese, day after day to give the needed amount of calcium.

Sources of calcium throughout the world. It is frequently pointed out that there are healthy people who do not drink milk or eat cheese. This statement is almost never true of Americans.

Some foods not used in our country are rich in calcium. The Hawaiians' chief source of calcium is a food known as *poi*. Many Oriental races obtain their calcium principally from soy-

beans and soybean curds, which form a staple food. A popular dish of the Chinese is pickled spareribs, which is prepared by chopping the bones fine and soaking them in vinegar. A single serving has been found to contain 1 gram of calcium.

Bones are used as a principal source of calcium by many peoples throughout the world: the Eskimos, the African natives, and, in former times, the American Indians. Their diet includes the pliable bones of fish, small game, and birds. In many instances, the more meat used, the more bones were consumed. It has frequently been pointed out that, by chewing the bones of fried chicken or game, people would gain a nutritional value greater than from the meat itself.

Bone meal, or bone ground so fine as to be quickly dissolved by the hydrochloric acid in the stomach, is now added to several cereals sold for babies. This procedure is wise, and other foods more generally used might well be fortified with such an inexpensive source of calcium.

Calcium requirements of small children. Relatively few minerals are stored in babies' bones before birth. The baby is born in a calcium-poor condition which may take months and even years to overcome. For this reason it is extremely important to begin giving an infant at the earliest possible date both vitamin D and the B-complex to increase the absorption of calcium. It is of equal importance to add cottage cheese to the diet by the fifth or sixth month, and to see that a quart of milk is taken daily.

From a great many experiments in which the calcium balance has been determined, it has been found that, to keep a child in positive calcium balance, 1 gram of calcium, the amount which is supplied by a quart of milk, must be taken into the body daily. When only a pint of milk is drunk, the losses of calcium exceed the intake. If this condition continues, growth is stunted. If milk is the sole source of calcium, even

three glasses of milk daily will cause many children to be in negative balance. A quart of milk daily, therefore, is considered the ideal for children, from birth until they are thirteen or fourteen years old.

Calcium requirements of adolescents. Somewhere between thirteen and sixteen years of age, boys and girls begin a period of unusually rapid growth. Several inches in height may be gained in a single year. In such cases, the long bones of the arms and legs are lengthening so rapidly that they demand tremendous amounts of minerals. If the teeth, which are growing little at this time, and the nerves, muscles, and other soft tissues of the body are not to suffer, the diet must contain unusually generous amounts of calcium. The rapidly growing bones will steal calcium from the soft tissues, if the diet is not adequate.

Boys, especially, show a tendency to spurt from short youngsters into six-foot men in the course of only two or three years. The taller they grow, the more calcium they need. In this case, a mere positive calcium balance is not enough. The rapidly growing child will need a greater positive balance than the slow-growing child. The enormous amount of calcium goes, not to build height, which is limited by heredity, but to solidify bones which have already lengthened.

The actual amount of calcium needed for the ideal bone growth at this time is not known and indeed varies widely with each individual. In order to give the bones all the calcium they need, from 1½ to 2 grams daily is certainly desirable. To gain this amount, cheese should be eaten once or twice daily, in addition to the quart of milk.

Calcium requirements of adults. Adults should have a daily minimum of 750 milligrams of calcium daily which would be obtained from three glasses of milk, if milk were the only source. Though children need calcium more than do adults

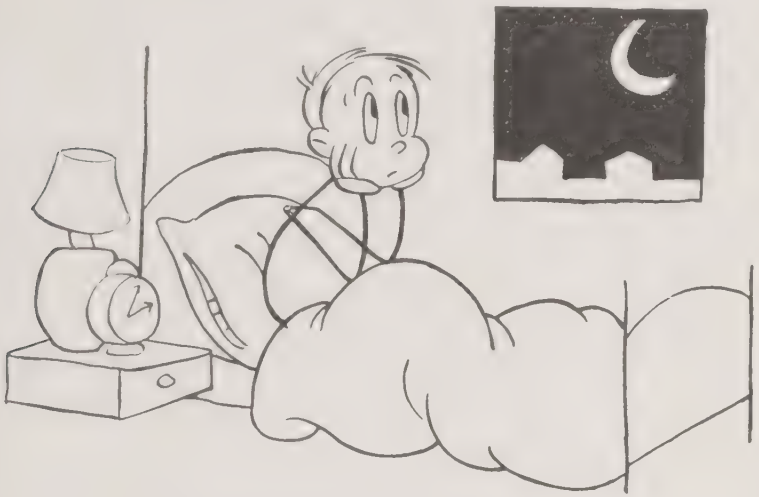
because of growth, fewer adults than children are eating calcium-rich foods. A great deal has been said about giving children milk, but adults have rarely been told of their calcium needs. You can do a tremendous amount of good by influencing the older people around you to eat more milk and cheese.

Until scientific research revealed otherwise, it was thought that the bones of older people became brittle with age, that they would break easily and heal slowly. Research shows that if the diet is good, and if calcium, phosphorus, and vitamin D are ample, larger amounts of minerals are continuously laid down in the bones and they actually become stronger with age.

It is now known that the years and years of partial deficiency of minerals, vitamin D, and especially ascorbic acid, in the diet of old people caused their bones to break easily. All too few people over sixty get even one glass of milk daily. The majority obtain vitamin D in no food and rarely, if ever, take sunbaths. Ascorbic acid, the need of which appears to increase with advancing age, is taken haphazardly. The reason for the fragility of bones becomes obvious. Bones need not break easily, and they can heal at any age, provided the diet is adequate in every respect and the digestion is such that the minerals and vitamins eaten are absorbed into the blood.

The calories in milk. There is a mistaken popular opinion that milk is fattening. Over half of the calories in milk are in the cream, which need not be used by people who wish to maintain their weight or to reduce. Every dairy selling whipping cream also has skim milk which has been run through a cream separator. Large amounts of skim milk are recommended on reducing diets because it is so filling that fewer fattening foods are eaten. Let us suppose you wish to reduce. During the morning you might be tempted to eat a doughnut (240 calories) but by drinking a glass of skim milk (92 calories) you are sufficiently satisfied to resist it. Similarly, another

glass of skim milk after school might help you to forego a candy bar having 250 calories.



He cannot sleep. He's just too dumb
To know he needs more calcium.

In many cases, people are so nervous that their nervous movements cause them to burn more calories than a relaxed person. If the nervous person adds milk to his diet, the calcium relaxes his nerves, he wastes less energy and hence burns fewer calories. He can gain weight without increasing his food intake, and it might be said for him that milk was fattening. No intelligent person, however, would desire to retain annoying nervous movements, in order to keep thin.

Advantages of powdered milk. Everyone should be familiar with powdered skim milk [1] and use it whenever possible. Although whole powdered milk may be purchased, it is much more expensive than the skim milk and quickly becomes rancid because of the butterfat it contains. The skim milk is sprayed into a strong breeze which dries the water and allows only the

[1] If you are not able to purchase this in your local store, it may be ordered from any large dairy.

solid material to remain. The milk solids contain all of the minerals and vitamins of fresh skim milk: riboflavin, calcium, phosphorus, and other vitamins and minerals.

One-third to one-half cup of the powdered skim milk is equal to the solids in an entire quart of fresh skim milk. Only the water, which amounts to about 92 per cent, is removed.

Powdered skim milk is inexpensive, compared with fresh milk. It keeps indefinitely if always dry. Because of its concentrated form, it may be used in far greater quantities than is possible with fresh milk. For instance, if a recipe for biscuits calls for a half cup of fresh milk, that amount of the powdered skim milk may be added directly to the flour, and water may be used instead of the liquid called for. In this way the biscuits will contain more than eight times as much milk, as when made with fresh milk, and eight times as much calcium and riboflavin.

Three fourths of a cup of powdered skim milk can be mixed with a quart of water and used in any way fresh milk would be used. Milk drinks made of this mixture taste richer and creamier than those made with fresh milk, and supply one and one-half times more calcium. Powdered skim milk may also be used in preparing cream soups, puddings, and ice cream.* It may be used in baking breads, such as muffins, cakes, and cookies. Many people learn to enjoy drinking it as a beverage, although the taste is not the same as fresh milk. It is delicious when mixed with fresh orange juice or other fruit juices.

Your calcium supply. Ideally, every person should have a quart of milk daily from birth to death. Wherever possible, milk to which vitamin D has been added should be used. Since vitamin D is in the cream, a dependable supply of vitamin D must be obtained from some other source in cases where weight reduction is desired or skim milk is preferable.

* See footnote page 66 for recipes using powdered milk.

Since it may not always be convenient to get a quart of milk daily, cheese should be used in some form at least once a day. The additional calcium obtained from cheese is particularly important for boys and girls in their teens, because of the rapid growth at that time. Even if the full growth has been obtained, the bones are often left rarefied and are made more solid by additional minerals. All foods prepared with milk, such as cream soups, cream sauces or ice cream, may be used to increase the calcium supply, in addition to the milk which is consumed as a beverage.

A great many people feel that they cannot drink milk. Usually they can take milk without any trouble if given generous amounts of vitamin-B complex. Actually milk is laxative because of the presence of favorable bacteria and because of its milk-sugar content.

Mustard greens, collards, chard, New Zealand spinach, kale, turnip, radish, and beet tops, and several other equally green leaves are excellent sources of calcium, but these are not eaten in sufficient quantities to be dependable daily sources. Every garden should be planned to produce leafy vegetables.

Another vegetable which is rich in calcium is the soybean, a food all too little used in America. Soybean flour is fourteen times richer in calcium than refined wheat flour, and baked soybeans are many times richer in calcium than baked navy beans. Every person should learn to enjoy this highly nutritious food and make it an important part of his diet.

Whatever be your source of calcium, see that it is supplied in at least adequate amounts every day throughout life. Keep in mind always that not all of the minerals eaten in the food reach the blood stream; that not all which reach the blood are retained by the body. For these reasons, your calcium intake should be generous. Get a quart of milk daily and eat cheese at least once each day in addition.

Projects

1. Obtain powdered whole or skim milk and prepare the following foods. (a) *Orange shake:* Squeeze 1 pint of juice from chilled oranges; add ½ cup powdered milk, 1 teaspoon sugar, 1 drop vanilla; beat until smooth; serve. (b) *Candy:* Combine 1 can sweetened condensed milk, 1 teaspoon vanilla, 1⅓ cups powdered milk; stir until smooth and add 1 cup coconut or broken walnuts; turn into a buttered pan and cut into squares after an hour. (c) *Junket:* To a pint of whole milk add 1 cup powdered milk, ½ cup brown sugar, 1 teaspoon vanilla; beat until smooth and heat to lukewarm; dissolve a junket tablet in a tablespoonful of water and mix into warmed milk; stir well and pour immediately into sherbet glasses. This recipe contains 2½ quarts of milk in a pint volume, yet the junket is creamier and more delicious than the usual variety.
2. List all foods you have eaten during the last twenty-four hours. Estimate your calcium intake and compare it with your requirement. Have you allowed any to be stored for future use?
3. Try to plan a diet adequate in calcium (1000 mg.) for a child who uses no dairy products. Be sure the amounts served could be eaten. Can such a diet be planned?
4. Estimate roughly the calcium intake of each member of your family. How many are getting their ideal amount? List means by which you can influence them to increase their calcium intake.

Topics for Discussion

1. If no milk can be used, what are the next richest sources of calcium? What are the sources in other countries? Are any of these foods practical for our use?
2. Give the amount of calcium needed and the foods which could supply that amount for the following: infants; a year-old child; a girl of fourteen who dislikes milk; a boy of sixteen; a woman of sixty with fragile bones.
3. What are the advantages of using powdered milk? What substance does it lack which is supplied by whole, fresh milk?

Chapter 28

YOUR PHOSPHORUS NEEDS

Though more than 99 per cent of all the calcium of the body is found in the bones and teeth, only from 70 to 80 per cent of the phosphorus is used in the skeletal structures. The remaining phosphorus is found in the soft tissues. Calcium never occurs in the body except associated with phosphorus. On the other hand, phosphorus is found combined not only with calcium but also with fats, carbohydrates, and proteins. The body of the average adult contains from 1 to 1½ pounds of phosphorus.

Functions of phosphorus. Phosphorus gives rigidity to bones and teeth. It is also an essential part of the nucleus of every cell in the body. It aids in the absorption of fats and sugars through the wall of the intestinal tract and acts as a carrier of fat in the blood. Phosphorus plays an important part in changing sugar into glycogen and in the burning of sugar and fats to produce energy.

Phosphorus and calcium parallels. In many ways, the information gained from studying calcium also applies to phosphorus. Phosphorus is equally as essential as calcium for the attainment of normal growth and skeletal development. Phosphorus passes from the intestinal tract into the blood stream under the same conditions under which calcium is absorbed. Phosphorus must be in acid to be soluble and the presence of vitamin D is necessary for its efficient absorption, especially in the young. The accurate measurement of the amount of phosphorus eaten and excreted tells whether the person is in nega-

tive or positive balance. As in the case of calcium, any excess can be stored in the ends of the long bones, provided that the excess is not lost from the body. Again, as in the case of calcium, this storage is at the beck and call of the parathyroid glands, depending on the body needs. The phosphorus content of tissues, like that of calcium, is never static, but is continuously changing.

He won't drink his milk, for he just doesn't know
That calcium is used to keep phosphorus in tow.

Phosphorus retention and balance. Unlike calcium, which is not richly supplied in foods, phosphorus is so widespread that at one time it was thought that a deficiency of this mineral could not exist. This supposition is now doubted.

The majority of people obtain sufficient phosphorus from the foods they eat. They may absorb generous amounts into the blood. But, unless sufficient amounts of calcium are included in the diet, phosphorus cannot be held in the body.

From 70 to 80 per cent of the phosphorus used by the body is used in combination with calcium. If too little calcium is eaten to allow this combination to take place efficiently, then the phosphorus is thrown off by the kidneys. Since phosphorus is largely excreted in the form of calcium-phosphorus salts, the body not only loses phophorus but the needed calcium as well.

Hence the deficiency of phosphorus is not due to the lack of the mineral in the food or to any failure to reach the blood, but to a loss from the body through the kidneys. The retention of phosphorus is, therefore, the greatest problem. If phosphorus is to be efficiently held in the body, calcium must be generously supplied in the diet.

Deficiency of phosphorus. It has been so difficult to prepare a diet for animals adequate in other respects, except for the phosphorus-containing foods, that this subject has been little studied.

In experiments carried out by Dr. McCollum and Dr. Day at Johns Hopkins University, it was found that rats, restricted at weaning time to a diet low in phosphorus, grew slowly for about two weeks, became ill, and soon died. Death comes more quickly in this case than in the case of any other mineral deficiency. The animals excreted large amounts of calcium. They became inactive and used their legs as little as possible. X-ray pictures showed that the bones progressively lost minerals. This loss became so severe that as death approached, only a faint shadow of the bones showed on the x-ray plates. The bones fractured spontaneously. The ribs collapsed to such an extent that the heart and lungs were compressed.

Phosphorus deficiency in farm animals has been extremely severe in many parts of the world, particularly in South Africa and Australia. It has also been observed in ten states in our country. The reason for the deficiency is that the animals ate foods grown on soils depleted in phosphorus. The soil deficiency, in turn, was caused by the continuous removal of that mineral in the grasses and grains produced on the land. It is interesting to note that, before the period when agriculture began, animals used to die on the land; the minerals from their bones were washed back into the soil; vegetation remained to decay; and the fertility of the land was not lost.

The farm animals lacking phosphorus showed the same abnormalities produced in phosphorus-deficient rats. The condition is readily corrected by the use of any form of phosphorus salt.

Sources of phosphorus. Almost every known food contains phosphorus, with the exception of refined fats and sugar. Phosphorus is necessary to the life processes of all cells, both animal and vegetable, which we use as food. The protein foods, milk, meat, eggs, cheese, cereals, nuts, and legumes, are especially rich in this mineral. Before a diet could be deficient in phosphorus, it would also necessarily be deficient in protein, iron, and the vitamin-B complex.

People may be deficient in phosphorus if they are using foods grown in soil too deficient in this mineral to support healthy farm animals. For example, it was found that of wheat grown in two different sections of the country, one contained less than half as much phosphorus as the other. This problem has been too little investigated.

The phosphorus content of milk, eggs, and meat shows little variation. These foods can be depended upon as excellent sources of phosphorus regardless of where they are produced. The reason is that the bones of the animals are called on to supply the mineral content of milk and eggs and the phosphorus needs of the muscle tissue which we eat as meat. For example, when cows are excreting larger amounts of minerals than they are eating, the calcium and phosphorus content of the milk is in the same concentration as the milk of normal cows. In eggs, a soft shell will tell of a mineral deficiency although the phosphorus content of the egg will be unaffected. However, the number of eggs laid and the amount of milk produced are decreased when minerals are deficient.

Body requirements of phosphorus. The body of the newborn baby contains a considerably larger amount of phosphorus

Healthy persons are mentally alert and enjoy study as well as play.

than of calcium; hence, slightly less than 1 gram of phosphorus daily is the amount considered ample. This is supplied by the milk likely to be taken by a baby in a day.

During the entire growth period the body needs about 1½ grams of phosphorus daily. Each day, additional phosphorus is held in the cells of the developing muscles and soft tissues; each day, phosphorus, together with calcium, is laid down in the growing bones and teeth. Should a deficiency exist, the soft tissues will steal needed phosphorus from the bones. This loss interferes with the development of the bones and may lead to the stunting of growth. After the cessation of growth and all throughout life, the average adult should have about 1 gram of phosphorus daily.

Points to be remembered. Even though little space is given to phosphorus, it cannot be overstressed that this mineral is as important to the body as is calcium; that the ability of the body to use phosphorus efficiently depends on the amount of calcium included in the diet. Even when a deficiency of phosphorus exists in the tissues, that lack is in all probability indirectly due to a deficiency of calcium. If calcium is not generously included in the diet, large amounts of phosphorus are excreted, taking with them some of the already limited supply of calcium. In this way large amounts of both minerals are lost from the body.

Except in the regions where the soil is deficient in phosphorus, the usual diet contains more than enough phosphorus and too little calcium. This problem is an important one which cannot be solved until people are educated to eat sufficient amounts of milk and cheese to supply their calcium needs.

Case History

Richard T. was thirteen years old, nearsighted, freckled, likeable, and unusually active both mentally and physically. He had won

all the medals given by the Boy Scouts, and his collections of both beetles and stones had overflowed his room and taken up parts of the basement and garage. A careful observer, however, could see that he was nervous and tense and that his disposition was not always the best.

Richard hated those very thick glasses he had to wear. He could not fight because of them, he could not play ball, and he felt they made him look like a panda. Yet he could see very little without them.

Richard's oculist was unusually interested in nutrition and liked to get at causes, whenever he could. When he read of the experiments on dogs where nearsightedness was produced by diets too low in calcium, phosphorus, and vitamin D, he asked Richard to go to a medical laboratory where a sample of blood was taken. The analysis showed that the blood phosphorus was 2.8 and the blood calcium 8 milligrams compared to the normal of 5 and 11 respectively, in almost a half cup of blood (100 cc.).

The oculist checked Richard's diet in detail and found that he had been obtaining so few of the B vitamins that neither calcium nor phosphorus could be efficiently absorbed; that he took no vitamin D in any form, hence phosphorus could neither be well absorbed into the blood nor retained by the body. Because of occasional attacks of asthma and a suspected milk poisoning, Richard was drinking very little milk.

The oculist planned a nutrition program for Richard which was adequate in every respect. Each month he examined his vision, and each month there was improvement. After six months, Richard no longer had to wear his glasses.

Projects

1. By using the tables on pages 464–487, plan a diet which will contain 1 gram of calcium and 1 gram of phosphorus. Note how difficult it is not to have a predominant amount of phosphorus.
2. Make a list of all foods eaten in the course of the day by some person who does not use milk or cheese. Compute the amount of phosphorus and calcium obtained from such a diet. Might this person actually be deficient in phosphorus?

3. Calculate the amounts of both calcium and phosphorus you have obtained in twenty-four hours. How does each compare with your daily requirements? Is it possible that you might lose phosphorus because of eating too little calcium?

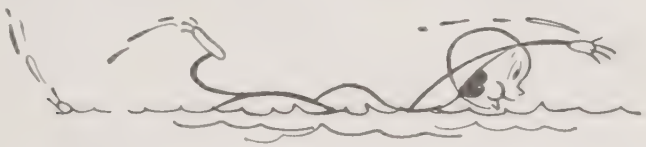
Topics for Discussion

1. If the stomach were removed, what would be the effect on phosphorus absorption?
2. How could a phosphorus deficiency exist if generous amounts were obtained from foods and were well absorbed into the body?
3. Calcium never occurs in the body except associated with phosphorous. With what other substances besides calcium does phosphorous combine?
4. Discuss the possibility of anyone being deficient in phosphorous although using adequate amounts of foods listed as containing phosphorous.

Chapter 29

A HEALTHY BLOOD STREAM

Healthy blood always shows under the skin, giving it a ruddy glow. This color shows because the under layers of skin are crossed and crisscrossed with millions of capillaries. Consequently, when the blood stream is healthy, the lips are definitely red; the ears are almost so; the fingernails are a pleasant pink; and the cheeks have color which surpasses any that can be artificially applied. Such attractiveness is everyone's right. How often have you seen such a person? As a wit has said, "Bring me a haystack, and I'll start looking."



Good rich blood will keep you going,
But if you lack it, you'll need towing.

Aside from creating physical beauty, red blood plays a decided role in maintaining vigor, endurance, and stamina. For these qualities alone, a healthy blood stream should be everyone's desire.

Normal blood formation. The bone marrow is the factory where red corpuscles are made. It is estimated that approximately one billion corpuscles are produced in a healthy adult every minute. There are trillions of these red cells in the entire blood stream.

In 1 cubic millimeter (an imaginary cube almost 0.04 inch on

every side), there are normally over five million red corpuscles. The number of cells in a cubic millimeter, which varies widely with individuals, is spoken of as the *blood count.*

It is not enough, however, to have a generous number of red cells. Each corpuscle must contain a normal amount of hemoglobin. There are ideally about 16 grams of hemoglobin in about a half cup (100 cc.) of blood. The accurate method of determining the amount of hemoglobin in the blood is by actual weight. Unfortunately this method is too expensive to be used widely by physicians.

The more usual method of estimating the amount of hemoglobin in the corpuscles is by comparing the color of the blood to that of a standard series of colors. The brightest red of the standard is considered 100 per cent hemoglobin. This color should represent 16 grams of hemoglobin, but is usually 14 grams or lower. Perhaps your blood would match the color marked 80 per cent. This color indicates that you have 80 per cent of the total amount of hemoglobin you could have.

Anemia. In anemia, the body either fails to produce enough red corpuscles, or the hemoglobin is below normal in amount. There may be too few corpuscles as well as too little hemoglobin. The person without healthy blood is listless, tires easily, and lacks pep and color. He cannot think clearly or quickly, and he forgets easily.

There are many causes of anemia: loss of blood from a hemorrhage; destruction of red corpuscles because of certain diseases; interference with the production of red corpuscles, as during infections; injury to the bone marrow, causing decreased production of blood cells. Anemia may also be produced by many drugs such as sulfanilamide. The more common cause of anemia, however, is a lack of iron in the diet.

Iron deficiency. Numerous studies have been made which reveal that from a slight to a severe anemia occurs in appalling

numbers of women and children. Many authorities believe that 90 per cent of the women in America are anemic.

Dr. Abbott and Dr. Ahmann of the University of Florida Agricultural Experiment Station made a study of the blood of almost nine hundred children. They used low standards by which 13.7 grams of hemoglobin were considered normal. Even then they found that 50 per cent of the children were anemic, and 31 per cent more were on the borderline of anemia. Many children with only 35 per cent of the normal amount of hemoglobin were attending school. The constant fatigue, inefficiency, and poor thinking due to anemia cannot be overestimated.

Similar studies have also shown that the extent of anemia is nothing less than a national disgrace. Still it has been proved beyond all doubt that, when an adequate diet rich in iron is given, both the amount of hemoglobin and the number of red corpuscles become normal.

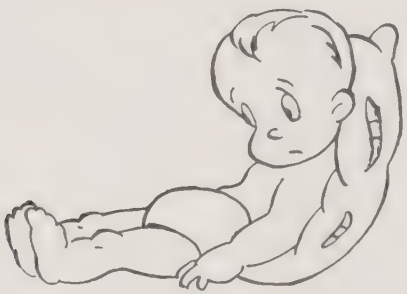
The greatest single cause for this widespread anemia is the discarding of iron from breads, cereals, and molasses in the process of refining.

Other needs for iron. Iron is found in all body cells. It is in the form of a substance known as *cytochrome*. The prefix *cyto* means cell, and *chrome* means color; therefore, the word means literally cell color. Cytochrome is extremely important in the breakdown of foods to produce energy.

Muscle tissues contain an iron-rich substance known as *myohemoglobin*. Since *myo* refers to muscle, this word means hemoglobin of the muscle. The amount of myohemoglobin does not vary. Even in the most severe anemia it does not give up its iron. When iron is deficient in the body, the needs of myohemoglobin are withdrawn from the available supply first. This fact indicates that hemoglobin of the muscle is of great importance.

Storage of iron. If an excess of iron is eaten, iron is stored in the liver, the bone marrow, and the spleen. This supply can be used in producing hemoglobin at any time when needed. Stored iron is quickly exhausted but is built up very slowly. The healthy person should have an excess of iron in his body at all times to insure against any possibility of anemia.

The need for copper. Anemia is easily produced in animals by giving a diet exclusively of milk. Such an anemia cannot be corrected by iron alone. If copper is given with the iron, however, the blood again becomes normal. Copper is necessary before iron can be used to make hemoglobin.



"I drink only milk. I've anemia's blight.
I lack iron and copper. Do I look a sight!"

Fortunately copper and iron occur together in foods. The richest sources of copper are: black molasses, liver, nuts, egg yolk, apricots, spinach, mushrooms, wheat bran, and wheat germ. The supply of iron and copper may be greatly increased by substituting black molasses and almonds, walnuts, and peanuts for other types of sweets.

Absorption of iron. It must be clearly understood that the iron in the blood is of two types. The iron coming from digested foods is carried in the plasma just as vitamins, sugars, amino acids, and other minerals are. This iron is the raw building material which can be withdrawn by the bone marrow and used by the muscles to supply their needs. The other type of

iron is chemically combined with hemoglobin inside the red corpuscles.

When iron-containing foods are completely digested, the iron is freed. If this iron is in tiny particles, or *ions,* it passes through the intestinal wall into the blood.

Iron dissolves only in acid. The hydrochloric acid in the stomach is therefore important in keeping iron in solution. The acid also changes many insoluble iron compounds into soluble ones so that they can be absorbed. Any foods which contain acids, such as citrus juices, buttermilk, apples, and sour fruits, aid the body in the absorption of iron.

Non-living, or inorganic, iron as that of iron rust or nails, if in small particles, is very easily absorbed into the blood. An old medical treatise entitled, *Self-help for People in Remote Places,* suggests, as a remedy for "the disease of pale ears," soaking iron shavings in water overnight, and drinking the water. Iron rust from nails or horseshoes would serve as an excellent treatment for anemia. Almost all non-living, or inorganic, iron, such as *ferric chloride,* is well used by the body. This type of iron is successfully used in the medical treatment of anemia.

Availability and sources of iron. When foods are analyzed for iron, the content of some of them is found to be high. Yet, when certain of these iron-rich foods are given to anemic animals, they fail to stimulate the regeneration of blood which the iron content would indicate.

It has recently been found that iron in many foods cannot pass from the intestines into the blood. It is not available to the body. For example, since blood itself is a rich source of iron, people have sometimes been advised to drink it in an attempt to cure anemia. But, since the body lacks enzymes to digest hemoglobin, the iron is not freed, or absorbed, and is consequently lost by way of the large intestine. Much of

the iron in meats is in the form of hemoglobin and is therefore not available to the body. Most of the iron in spinach and in some other vegetables is held in compounds which, like hemoglobin, cannot be digested; therefore, the iron fails to be absorbed.

Extensive studies have been made of the effect of foods in curing animals which were first made anemic by an exclusive milk diet. One group of anemic animals is usually given a known amount of easily absorbed iron salt. A definite regeneration of hemoglobin follows. Food which furnishes exactly the same amount of iron is given another group of anemic animals, and the regeneration of their blood is compared with that of the first group. By this means the amount of iron which is available to the body or which is absorbed into the blood has been determined.

Although fruits are not rich in iron, all of the iron from apricots, apples, bananas, pears, peaches, and cherries reaches the blood stream. Apricots have been found to be particularly valuable for curing anemia. The iron from peanuts, celery, and carrots is 100 per cent available, as is that from black molasses—the richest source of iron.

Meats are rich sources of iron, but only the following percentages are absorbed: 15 from ham; 50 from muscles meats; 70 from liver; and 80 from heart. Soybeans are extremely rich in iron, of which 80 per cent reaches the blood. In a mixed diet as a whole, only about 50 per cent of the iron in foods is available. The other 50 per cent is lost by way of the large intestine. It is obvious that the quantity of iron in foods is of lesser importance than the actual amount which may be absorbed for use in the body.

Dr. Whipple and Dr. Carter of the Rochester School of Medicine produced anemia in dogs by withdrawing blood, taking out the red cells, and then reinjecting the plasma into

the dogs. Varying types of diets were given them. It was found that liver produced the most hemoglobin, kidney second, apricots third, and eggs fourth. Many foods which contained as much or more iron failed to be good blood builders.

The span of red corpuscles. Red corpuscles circulate in the blood stream about six weeks before they finish their span of usefulness. They are then withdrawn and destroyed. The spleen and liver are the graveyards for corpuscles. Here they are broken down by enzyme action.

The non-iron parts of the hemoglobin are excreted as waste products by the liver into the bile. These are known as bile pigments. Oxygen combines with these pigments and changes them from green to yellow and then to brown. These pigments give the color to the feces and the urine. When corpuscles are destroyed, 85 per cent of the iron can again be used by the body. The remaining 15 per cent is excreted as worn-out iron.

A baby's need for iron. If you have ever seen a newborn baby, you have noticed how red it is. Infants are born with large amounts of hemoglobin, about 18 to 20 grams in 3⅓ ounces of blood. This quantity decreases rapidly during the first month after birth.

Such a decrease of hemoglobin cannot be prevented by giving iron. It is thought that the large amount of hemoglobin is needed to carry efficiently the small amount of oxygen obtained indirectly from the mother. A somewhat similar condition is found when people go into high altitudes. In order to obtain more oxygen, the body increases the number of red corpuscles. The larger the number of cells, the more hemoglobin they can contain, and the more oxygen can be supplied to the tissues.

The healthy infant is born with a rather large amount of iron stored in the liver. A diet of milk alone, however, will

produce anemia in babies just as it does in experimental animals. The daily iron requirement for an infant is 7 milligrams. Only about 0.1 milligram is absorbed from an entire quart of milk. If milk were the only source of iron, 70 quarts daily would be needed.

"I've good red blood. .I eat egg yolks,
They're rich in iron. So, tell your folks."

Anemia in a baby can easily be prevented. Within a few days after its birth, water in which iron-rich vegetables have been cooked should be given daily. The yolk of a hard-boiled egg should be started at the third month. Whole-grain cereals, stewed fruits, puréed vegetables, and scraped liver and beef should be given by the fourth or fifth month. Such a diet would prevent anemia.

Iron needs during growth. We have seen that anemia in growing children is all too common. During this period the iron requirement is high because the volume of blood is continually expanding. Both the amount of hemoglobin and the number of red corpuscles increase.

If the diet is carefully planned to include liver, baked potato of which the skin is eaten, only whole-grain breads and cereals, and particularly black molasses, the iron needs of the growing child may easily be supplied.

Iron needs during adolescence. Adolescent boys have good appetites, eat heartily, are rarely trying to reduce, and usually

like iron-rich foods. Despite the fact that their requirements are high because of growth, they are rarely anemic.

On the other hand, most girls are anemic because they have a higher iron requirement than boys have. Literature of olden times tells how young ladies swooned on every occasion, a condition which was caused by anemia. During adolescence a diet for a girl should contain as much iron as possible.

Iron requirements of adults. Because of better dietary habits and lower iron requirements, men are much less likely to be anemic than women. Anemia in women is the rule rather than the exception.

Our standards of normal blood. Every life process depends upon the supply of oxygen brought to the cells, the removal of carbon dioxide, and the sustaining of a neutral body fluid. These are all functions of hemoglobin. Even slight anemia results in a decrease of energy and mental alertness. Is it not therefore important to refuse to be satisfied with anything less than the best blood a healthy body can produce?

The so-called normal blood has the following amounts of red cells and hemoglobin:

	COUNT, CELLS PER CUBIC MILLIMETER	HEMOGLOBIN, GRAMS PER 100 CC.	HEMOGLOBIN, PER CENT
Women and girls	4,500,000	14	80–100
Men and boys	5,500,000	16	100

When an adequate diet rich in iron is given men who have 16 grams of hemoglobin in 3⅓ ounces of blood, the amount of hemoglobin is increased little, if any. The number of cells cannot be increased much beyond 5,500,000 in each cubic millimeter of blood. This failure to increase indicates that 16 grams of hemoglobin and 5,500,000 red corpuscles are near the upper

limits. These amounts appear to be ideal and are compatible with full health.

When an adequate diet is given to infants, growing children, adolescent girls, and women of all ages, normal hemoglobin of 14 grams or less increases to approximately 16 grams; the average blood count of 4,500,000 increases to about 5,500,000. This improvement shows that the so-called normal hemoglobin and blood count are in reality not normal at all.

If you're wan, worn, and weak, and fear you don't rate,
Plan more iron in your food, and you'll then get a date.

When animals are well fed, there are no age or sex differences in the color of the blood or the number of red corpuscles Why should such differences be considered normal in people?

The lower standards of blood are old ones, accepted before it became known that improvement followed a completely adequate diet. They are nothing more than averages of the amounts of hemoglobin and number of red corpuscles found in large groups of people with passable health. These standards, however, are still in use. Because of low standards, people are frequently told that their blood is normal when anemia actually exists.

Our standards of iron requirements. The Food and Nutrition Board of the National Research Council have recom

mended the following daily minimum allowances of iron:

	MILLIGRAMS OF IRON
Children	
Under 1 year	6
1–3 years	7
4–6 years	8
7–9 years	10
10–12 years	12
Boys and girls over 12 years	15
Men	12
Women	12

These quantities have been criticized as being too low, particularly for women, growing children, and adolescent girls. If the recommendations for these groups were increased by 25 per cent, they would probably be sufficient to sustain health. For example, a 6-year-old child should have 10 milligrams of iron daily, an adolescent girl 18 milligrams, and an adult woman 15 milligrams. Iron in excess of body needs is not absorbed into the blood but is thrown off with body wastes; therefore large amounts are not harmful.

The diet must be adequate in all respects. Although a deficiency of iron is perhaps the most common cause of anemia, it is by no means the only cause. Since red corpuscles are made of protein, even a mild deficiency of protein can result in too few corpuscles. A partial lack of any one of several of the B vitamins, thiamin, niacin, pyridoxin, biotin, and especially folic acid, results in anemia. When iodine is undersupplied, the bone marrow can no longer produce red corpuscles normally, and again anemia occurs. All of these requirements must be supplied. They could be largely met if a half cup of wheat germ, rich in iron, protein, and B vitamins, were salted with iodized salt and eaten daily as a cereal.

Examine yourself carefully before the mirror. If your cheeks, lips, and ears are not sufficiently red to give you a glowing color of health, see that your diet is adequate in all respects and particularly rich in iron.

Project

1. Buy a Tallquist hemoglobin scales from any drug store or borrow one from a physician. On this scale 100 per cent hemoglobin is equivalent to 13.7 grams. *Sterilize* a sharp needle in a flame. Wipe the tip of a finger with rubbing alcohol. As you pinch it (to prevent pain) quickly prick it with the sterile needle. Collect the drop of blood on a piece of absorbent paper. Wipe skin again with alcohol. Compare the color of the blood specimen to the colors on the hemoglobin scales. Instead of a finger tip, the lobe of an ear is often used.
2. Wash a piece of beef free from all blood. Does any red color remain? What gives this color to the meat?

Topics for Discussion

1. Where are red corpuscles formed? How many are considered to be normal? What is meant by 80 per cent hemoglobin?
2. Does anemia mean too few red corpuscles, too little hemoglobin, or both? What occurs when anemia exists? Why is fatigue a prominent symptom of anemia?
3. In what other ways does the body use iron besides building blood? Where and under what conditions can iron be stored? What are the two types of iron in the blood? Why is iron not well absorbed in many cases? Why is it not always available after foods are digested? What are the sources of iron and copper?
4. Why are the following likely to be anemic: babies; growing children; adolescent girls? Why do boys and men usually have healthy blood?
5. Why do the present standards for judging blood appear to be inadequate? Why are minimum requirements of iron inadequate? What should be the recommended iron requirement for people of different ages?

Chapter 30

HOW IODINE CAN HELP YOU

Have you ever noticed that some people can eat generous amounts of food without gaining and that others gain easily even though they eat little? Some people are active and alert; others are sluggish, both in thinking and in movement. Have you observed that some people rarely suffer from the cold? Others must take an electric pad or hot-water bottle to bed each night. They have cold hands and feet and are uncomfortable at ordinary room temperatures. Some people have strong attractive fingernails which never break, thick hair, little of which falls out. Others have nails which break easily and hair which falls at such an alarming rate that they sometimes fear baldness.

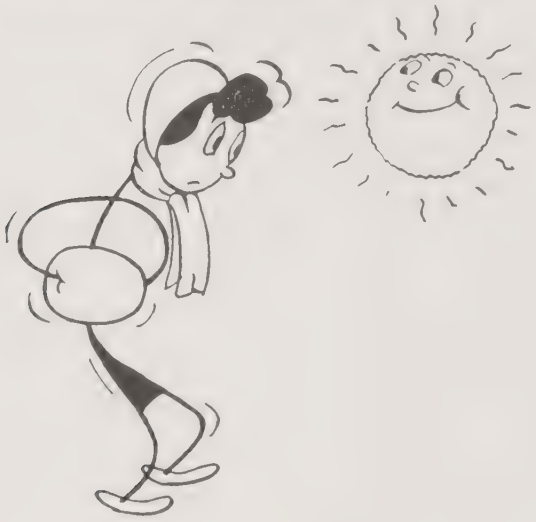
It is possible that such differences can be due to an almost infinitesimal amount of iodine in the diet. This amount is so small that it seems of no importance, and yet it is so important that it can make the difference between mental alertness and stupidity.

The body's need for iodine. Iodine is needed by the thyroid glands, which are situated on each side of the wind pipe. These glands, when given iodine, produce a chemical messenger, or hormone, known as *thyroxin*. This substance has a profound effect upon our growth, mental and physical development, and the maintenance of health throughout life. The effect of the potency of thyroxin can be shown experimentally. When it is given to tiny tadpoles, frogs which are no larger than flies are developed.

If the glands are to do their work efficiently, the supply of

iodine cannot be haphazard. It must be furnished in the diet day after day, year after year, throughout life.

Partial lack of iodine. A partial lack of iodine causes *goiter,* which is an enlargement of the thyroid glands. Such an enlargement is an attempt on the part of the body to compensate for the lack of iodine and to use the inadequate supply more efficiently. The amount of thyroxin thus produced by the



If you shiver in spite of the sun's warm glow,
Maybe your supply of iodine is low.

enlarged glands remains about the same as that produced by normal glands given plenty of iodine. Aside from the slight fullness and perhaps a mild pressure in the neck, there may be no other symptoms. Goiter, however, is a danger signal, pointing to possible trouble ahead.

If you have only a partial deficiency of iodine, the swelling in the neck is usually so mild that it goes unnoticed. But, you can learn to detect even small goiters. Stand before a mirror and turn your head from side to side. If the ligaments in your neck appear clearly, chances are that your thyroid glands are normal in size. If you are otherwise slender and yet can

scarcely see these ligaments when your head turns, your glands may be somewhat enlarged and in need of more iodine.

If you can't see the ligaments in your neck,
A lack of iodine your health might wreck.

The amount of goiter. Goiter is usually thought of as a disease of women and children. However, enlistments in both World Wars revealed a startling amount of goiter among men. Goiter is most prevalent during adolescence. A recent survey of the Cincinnati elementary schools revealed that 30 per cent of the boys and 55 per cent of the girls had goiter. Studies made by the United States Department of Public Health showed that in Minnesota, 70 per cent of the girls and 40 per cent of the boys had goiter. In Portland, Oregon, which is near the coast, 40 per cent of the girls and 22 per cent of the boys were afflicted. Any observant person trained in health is appalled at the amount of goiter existing even now throughout the middle west.

History of iodine deficiency. Goiter has been known since very early times and was described by Marco Polo as being common on the plains of Asia. It has especially afflicted people of the mountainous areas where little iodine is found in the soil.

Goiter has occurred so generally in many regions as to be considered normal. It is said that, in the past, it was usual for

old men in Switzerland, holding grandchildren on their laps, to express the desire to live until the children's necks became enlarged. Many of the paintings of the old masters show women and children with advanced goiters. In fact, a full round neck has often been considered a point of beauty. On the other hand, the disease has been unknown in places where sea fish forms the principal item of food, as in Japan and the South Sea Islands.

The discovery that iodine was effective in the treatment of goiter was indirectly due to the Napoleonic wars. The British blockade of the French coast cut off the importation from South America of minerals used in making gunpowder. In an attempt to obtain these minerals from the ashes of seaweeds, iodine was found. Since early times, the eating of seaweed had been known to affect goiter favorably. The discovery of its presence in seaweed caused iodine to be tried as a definite treatment for goiter.

The value of iodine. One of the first experiments in this country which showed the value of iodine was carried on by Dr. Marine and Dr. Kimball in 1917. They gave *sodium iodide,* a salt of sodium and iodine, twice a year to each of 2190 school girls in Akron, Ohio. Only five girls who received the iodine developed goiter. On the other hand, almost 500 cases of goiter developed among an untreated group of 2300 girls. This work proved conclusively that goiter could be prevented. In spite of the fact that this study was made years ago, goiter in this country is still rampant.

Symptoms of thyroid deficiency. We have seen, when iodine is insufficiently supplied, that the thyroid gland can enlarge to produce additional thyroxin. On the other hand, in cases where, although the gland is not enlarged, iodine is partially lacking, the lack causes a decreased production of thyroxin. Frequently the fullness of the neck will disappear

at about the age of twenty. Nevertheless, the partial lack of iodine continues, and again too little thyroxin is produced. Many abnormalities result. Let us see how these can interfere with health.

The thyroid is to the body what an accelerator is to a car; it controls the speed of the engine. When the accelerator is pressed down, the engine races. Similarly, when much thyroxin is produced, all body activities are carried on more rapidly than is normal. When the accelerator is touched only lightly, the engine idles. In the same way, too little thyroxin allows the body activities to become sluggish. In such a case, the person breathes more deliberately. His heart beats slowly. There are fewer and less vigorous contractions of the digestive tract and therefore a tendency to constipation. Less calories are burned to produce energy. These changes result in many subtle abnormalities, which are not compatible with health.

The person who lacks iodine to the extent that his thyroid glands do not produce enough thyroxin is lazy, has no endurance, and puts on weight easily. These symptoms are due to the fact that less sugar is burned to produce energy. The less sugar burned, the more sugar is left to be stored as fat. Because of decreased energy production, the heart slows down, and changes occur which are the results of poor circulation: cold hands and feet and dry skin; lifeless hair, lacking in luster and falling out easily; thin fingernails which peel or break easily. Memory is often faulty because of the poor circulation to the brain. Headaches are not uncommon. Even though such a person is cold when others are warm, he also suffers abnormally in extreme heat. His slowed circulation fails both in heating and in cooling his body as efficiently as it should.

When the body lacks iodine to the extent that too little thyroxin is produced, anemia is the rule. The bone marrow

fails to produce enough red blood cells. This anemia exaggerates the fatigue due to too little sugar being burned. Such symptoms vary, depending on the severity of the iodine deficiency. They may be so slight that the person considers himself quite normal. On the other hand they may become extremely severe. Regardless of the degree of severity, such conditions rob the person of his full mental and physical vigor.

Studies of this condition reveal that as many as 40 per cent of the women in many communities suffer from abnormally low production of thyroxin. Such a condition may be prevented by adequate amounts of iodine taken daily. In the majority of cases, health is restored by the addition of iodine to an otherwise adequate diet.

Cases exist where the damage appears to be irreparable; the thyroid gland can no longer produce sufficient amounts of thyroxin even though supplied with iodine. Fortunately thyroxin is extracted from thyroid glands of animals and is used medically for the relief of such persons, who should, of course, be under the care of a physician.

The taking of thyroid. Thyroid glands obtained from slaughterhouses are dried and pressed into tablets. These tablets are used by physicians in the treatment of severe thyroid deficiency. In cases of myxedema or cretinism, conditions which result from a total lack of iodine, they are of untold value.

When thyroid substance is taken by mouth, the action is essentially the same as that produced by the healthy gland. But, it is very easy for a person to take more thyroid than his body needs. In such a case, body activities are exaggerated, and extreme nervousness is apparent. The heart is forced to beat too rapidly and damage sometimes results.

Unethical advertisers, who wish to make money, have often

put reducing pills on the market. They imply that overweight people may eat heartily and that no additional exercise is necessary if they take these pills. Such tablets are apt to contain so much thyroxin that food is burned to produce the energy needed for increased activities of the heart, lungs, intestines, and in fact all body cells. Many otherwise sound hearts have been damaged in this manner.

Under normal conditions, the thyroid gland of a healthy person continually produces a certain quantity of thyroxin, which circulates in the blood at all times. The healthy gland never produces too much thyroxin. When thyroxin is supplied by thyroid tablets, there is no need for the gland to produce more. Like an arm kept in a sling, this gland then has no work to do. If the tablets are taken over a long enough period, the thyroid gland becomes unable to carry on its normal duties. For these reasons, thyroid substances are dangerous drugs and should never be taken except under the careful observation of a competent physician.

Exophthalmic goiter. The disease in which too much thyroid is produced is called *exophthalmic goiter*. In goiter belts, this disease occurs largely in people whose thyroid gland is already weakened because of lack of iodine. This type of goiter has been considered an infection of the weakened thyroid gland, but its exact cause is not clear.

In this disease, the heart beats too rapidly. A pulse of 130 or more beats a minute is likely to be found. The patient loses weight, is extremely nervous, and suffers from heat. The eyes often become prominent and somewhat protruding. Formerly, this condition was attributed to the giving of too much iodine, but such is not the case. In fact, this type of goiter is treated medically with large amounts of iodine.

There is no condition where diet is so extremely important

as in exophthalmic goiter. Calories, all vitamins, and all minerals must be given in larger than usual amounts. The need is particularly great because the body is working at such a high speed that the requirements are greater than usual. Moreover, food is being forced so quickly through the digestive tract that absorption is incomplete. The person suffering from this disease should always be under the care of a physician. His diet should be planned with the utmost care. Since such a disease occurs largely in the goiter belts, the carelessness of preventing seemingly harmless goiter is all the more deplorable. It may lead to this extremely serious condition.

Danger signals. Even the slightest fullness in the neck should be interpreted as a danger signal. Let us now summarize why:

1. The goiter may continue to enlarge to such an extent that it will need to be removed surgically. It may disappear and start growing later, at a time when the need for iodine has again increased.
2. The goiter may disappear. However, the continued but less severe lack of iodine can indirectly cause sluggishness of body activities. The sluggishness can lead to many uncomfortable changes due to too little energy produced or to poor circulation.
3. The unhealthy thyroid gland may change to cause the serious disease spoken of as exophthalmic goiter.
4. The iodine deficiency may become so severe as to cause myxedema.
5. If the woman lacking iodine has a child, she runs the risk of having an idiot, known as a cretin. Thousands of such children have been born.

In view of these danger signals, iodine should always be generously supplied in the diet of every person. Iodine requirement may decrease so much after adolescence that the amount in the ordinary diet is enough. Then the goiter will disappear, and no harm will result. Nevertheless the danger always exists if a goiter has once been evident.

Case History

Eleanor J. lived in Minnesota where goiter was a common occurrence. Her sister had had a goiter removed and always wore a string of large beads to hide the scar. Eleanor remembered waiting, frightened, at the hospital while the operation was performed, and she did not want to go through the same operation herself.

When the school doctor pointed out that Eleanor had a goiter, she felt alarmed but was comforted by the doctor's statement that if iodine were taken daily, the goiter would disappear. He gave her a solution of iodine and asked her to take 6 drops daily, which she did conscientiously. Although her neck was quite large when she started taking the iodine, the enlargement gradually disappeared, and, within a few months, the physician told her that her neck was normal. To prevent the return, Eleanor sees to it that only iodized salt is used in their home.

Topics for Discussion

1. How is iodine used in the body? What does a mild goiter indicate? How much goiter exists? What is the proof that goiter can be prevented? Why are goiters likely to disappear following the growth period? Why should a goiter be interpreted as a danger signal?
2. If enough iodine is given to prevent goiter but too little to support full health of the thyroid glands, what symptoms result? To what is each symptom due? Why do they vary with individuals?
3. What harm may be done by taking thyroid extract? How could overdosage of thyroid extract increase the needs for other body requirements? How could it interfere with absorption?

Chapter 31

YOUR IODINE REQUIREMENTS

In America, goiter is especially prevalent around the Great Lakes and in the Pacific Northwest. Since the chief source of iodine is the ocean, the only part of the country where sufficient iodine may be obtained is a narrow strip along the Atlantic seaboard and around the Gulf of Mexico. In this coastal strip, which in recent geologic ages formed the floor of the ocean, there are iodine deposits in the soil, as is the case in parts of Kansas, South Dakota, Utah, Western Texas, and New Mexico. Foods grown on these soils contain iodine. Other soils, although near the coast, contain little or no iodine. Vapors from the ocean, which, when inhaled, supply some iodine directly to the blood, are blown inland no farther than about three miles.

Many cities, particularly near the Pacific Coast, use mountain water or melted-snow water, which is entirely free from iodine. Large numbers of the people using this water suffer from iodine deficiency.

Sources of iodine. Many foods completely lack iodine. The amount of iodine in foods grown in this country varies so widely that almost no food may be depended upon as a reliable source. Cranberries grown in the salt marshes along the Massachusetts coast are almost the only exception. Ocean fish and sea foods are excellent sources of iodine, whereas fresh-water fish sometimes develop goiter, and their muscle tissue may be iodine free.

Iodine is sometimes added to fertilizer and to the feed of

dairy cows and laying hens. Dairy products and foods produced under such conditions contain appreciable amounts of iodine. These practices should be extended.

Many cities have added iodine to their water supply, but this provision has often proved expensive. In many cases, too little iodine has been added to prevent goiter entirely. The solution to the goiter problem must also take into account the country people, who have their own wells.

If you would like to stay slender as older you grow,
Use of iodized salt might keep your weight low.

Iodized salt has been on the market for many years. It contains one part of sodium or potassium iodide to one hundred thousand parts of salt. The use of this salt throughout life generously supplies the body with all its iodine needs. Such salt is approved by the Council on Foods of the American Medical Association.

The continuous use of iodized salt will completely prevent goiter. A recent study was conducted in Cleveland to ascertain the amount of iodized salt used. It was found that so few people bought iodized salt that 33 per cent of the girls in Cleveland had goiter, which was the same percentage with the disease when iodized salt was first put on the market.

Despite the fact that iodine is so greatly needed throughout the country, it has been revealed by similar surveys that only about 15 per cent of the people use iodized salt. It is difficult to understand such carelessness, stupidity, and disinterest in health.

Excessive doses of iodine. In studies carried on at the Iowa Experimental Station, hogs were fed 40 milligrams of potassium iodide daily for five months. This amount is four hundred times the human daily minimum requirement. Far from being harmed, the hogs showed increased growth and better health.

Pigs were fed as much as 1 gram of iodine daily for an extended period, and no bad effects were found. This amount is ten thousand times the daily human requirement. In still another study, dairy cows were fed two thousand times the daily human minimum requirement for a period of two years. During this time milk and butter production was increased, calves were normal, and the cows remained in excellent condition.

Certainly no harmful effects have come from the use of iodized salt. Since this product is approved by such a conservative and careful organization as the American Medical Association, all fears concerning its use should be dispelled.

Kinds of iodine. The food faddists have had much to say about the value of eating organic iodine. They frequently warn people not to use iodized salt. At the same time, they sell tablets of dried seaweed or other such preparations as an iodine source. They claim that such iodine is different and more healthful. The price of iodine obtained in this way is many times greater than that of iodized salt.

The term, *organic,* refers to a substance which comes from living tissue, either plant or animal. An example of organic iodine would be the iodine-containing amino acids found in the proteins of the thyroid gland. Other examples of organic

minerals are sulphur in protein and iron in blood. On the other hand, *inorganic* substances are those which are not living, such as the minerals in rocks or soil. The body contains and uses both organic and inorganic, or living and non-living, minerals.

In sea water, the iodine exists merely as non-living salts, potassium iodide and sodium iodide. Both seaweed and ocean fish must have water to carry on their life processes. The iodine salts contained in sea water are drawn into the tissues of the sea plants or animals. The iodine in either ocean fish or seaweeds is therefore largely the same form as that added to iodized salt.

Vitamin deficiencies and the thyroid. Infection of the thyroid gland can be produced experimentally by diets low in either vitamin A or ascorbic acid. The production of such an infection is brought about much more easily if the gland is already unhealthy because of lack of iodine.

The vitamin-B complex also has a profound effect on the action of the thyroid gland. By experiments in which this effect was particularly studied, the output of thyroxin was found to be decreased 80 per cent when no vitamin-B complex was included in the animals' diet. Similarly, human beings lacking thiamin show marked thyroid deficiency. Nevertheless, an appalling number of people, even small children, are taking thyroid extract without adding either iodine or vitamin-B complex to the diet.

Increased needs for iodine. There are many times in life when larger quantities of iodine are needed. But, no additional amounts of iodine need be taken at these times if one uses iodized salt throughout life.

The iodine requirement for developing babies is about three times that of an adult. Babies less than six months old are rarely given salt in any quantity. In goiter belts it is often rec-

ommended that a few drops of a standard iodine preparation, known as *Lugol's Solution,* be added to the baby's formula.

The requirement for iodine is so increased during adolescence that goiter is likely to develop at this time, even though the amount of iodine in the food has not decreased over that used when no goiter existed. At about the age of twenty, the iodine requirement again drops, and in a large percentage of cases the goiter may completely disappear. It is at this time, however, that the symptoms of low thyroid appear and manifest themselves during many years to come.

The need for iodine increases during any infection. Foods well salted with iodized salt should be served at this time. Thyroxin, the output of which is increased to normal by iodine, also aids in the healing of wounds and injuries.

The value of iodized salt. The knowledge of iodine requirements has come from careful studies of the intake and secretion of people in goitrous and non-goitrous regions. It has been found that if people eat as much as 0.1 milligram of iodine daily throughout life, no goiter develops; therefore, this amount is considered the minimum daily requirement for children and adults. Though a minimum amount of any one substance may be enough to prevent disease, it is not enough to promote ideal health.

Labeling laws state that the actual amounts of minerals and vitamins contained in any packaged food must be printed on the labels, and that the amount of each be compared with human minimum daily requirements. The one exception to this law is the labeling of iodized salt. People who eat a generous amount of iodized salt obtain somewhat more iodine than the minimum daily requirement. It was feared, therefore, if the salt were labeled in this respect, that people would feel they were getting too much iodine. Such people would be likely to decrease the use of the salt. In this case, such labeling might

indirectly be the cause of an actual increase of goiter. This attitude is justified, because people do not realize that iodine may be easily lost in the urine, that greater quantities are needed at some times than at others, that many people eat very little salt, and that a slight excess of iodine is desirable. If you use at least a teaspoonful of iodized table salt daily, the minimum iodine needs of your body under normal conditions are likely fulfilled.

Cost of neglect. Every year millions of people who have not obtained a normal supply of iodine pay for their neglect through a lack of mental efficiency and alertness. Aside from the pain and misery involved, hundreds of thousands of dollars are spent each year for the surgical removal of goiter, which could have been prevented by small foresight at no extra cost.

Dr. Campbell of the Department of Medicine at the University of Toronto writes in a booklet issued by the *Canadian Medical Journal:* "The most effective solution to the goiter problem at present seems to be the addition of small amounts of iodine to salt. This has been done and is now available to families alert to its advantages but fails to reach a great part of our population. To ensure its benefits, compulsory iodization of all salt sold for human consumption will be necessary. Where this has been done, as in Switzerland or Austria, the results have been most gratifying."[1] It would seem that the intelligence of a person may be judged by the kind of bread he chooses, as well as by the kind of salt he buys.

Case History

Nell F. worked in an office in Chicago. The work was not easy nor the pay good, but, with careful planning, there was enough money to support herself and her mother. It was only when sickness occurred and medicines had to be paid for and doctor bills settled that the sledding was tough.

[1] *Nutrition in Everyday Practice,* p. 51.

Nell's mother was not especially well. For years she had had a goiter but it did not bother her much, as there was only a slight pressure on her neck now and then. Of course it disfigured her a little, but she had seen worse ones many times. Her physician had asked her to take iodine repeatedly and Nell always urged her to follow his instructions. She did take it for a few days, but she could not notice that she felt better so she discontinued it. In fact, she always felt rather cheated that the physician did not give her some mysterious pills or a tonic. She reasoned that such a little bit of iodine could not be expected to help. As to making the effort to buy iodized salt, she never gave it a thought.

When she was about forty-eight, the goiter began growing rapidly. She became extremely nervous, her heart pounded, her hands trembled, her thoughts became confused. Her physician told her that the goiter had to be removed surgically.

The physician was extremely considerate of Nell, made the fee as modest as he could, and let her pay a little on it each month. Even at that, Nell was forced to give up many small pleasures, to make over her last year's hats and dresses, and to eat less at lunch in order to pay the bill. Sometimes she was a little bitter because of the realization that her sacrifices and her mother's suffering might have been avoided at no extra cost if her mother, during the past twenty years, had only used iodized salt which was available in any grocery.

Project

1. Conduct a survey of the amount of iodized salt used in your community. Let each student find out from ten families the kind of salt they use. How might you influence people to use more iodized salt?

Topics for Discussion

1. Why are most foods unreliable sources of iodine? What foods are exceptions? Is food iodine better than the form of iodine added to salt?
2. Why can eating excessive amounts of iodized salt do no harm? When are the iodine requirements particularly high? Is enough iodine added to salt to be of actual value?
3. What do you consider the best method of stamping out goiter?

Chapter 32

YOUR NEEDS FOR OTHER MINERALS

The ashes left when wood is completely burned are in reality minerals once held in the cells of a tree. These minerals were necessary for its life processes. In the same way, when foods are completely burned outside the body, only ashes, or mineral matter, remain. Inside the body, the same minerals are freed in digestion, but the cellulose remains.

When a food is analyzed for its mineral content, the chemist weighs a sample with great accuracy. He then places it on a porcelain dish in an oven which can be heated to an extremely high temperature. The food first smokes and turns black, just as forgotten toast burns. After continued heating, the food is completely burned to carbon dioxide and water, both of which escape into the air. Only white ash, or mineral matter, remains.

All natural, unrefined foods contain minerals. Those minerals and vitamins were necessary for the growth processes of the animal and vegetable life which we later use as food. When natural foods are burned, quantities of sodium, potassium, and chlorine are left, as well as calcium, phosphorus, iron, and copper.

Sources of sodium, potassium, and chlorine. Potassium is widely found in muscle meats and in vegetables. Small growing plants are particularly rich in this mineral.

Sodium is in the juices of meats, is especially high in the blood, and occurs in almost all vegetables.

There is little chlorine in foods of the vegetable kingdom,

but it is richly supplied in meats. The chief source of both sodium and chlorine is ordinary table salt. Salt, which is made up of the two elements, is known chemically as *sodium chloride.*

The body's control of its minerals. Although your diet may vary from generous amounts of potassium, sodium, and chlorine one day to little the next, the quantities remaining in your body are quite constant. The kidneys either excrete the minerals not needed or else prevent their loss at times of shortage.

If larger amounts of ordinary table salt are eaten than are needed at one time, thirst is created, and perspiration is increased so that the excess salt is quickly thrown off. As much as three teaspoonfuls, or 15 grams, of salt may be excreted in perspiration in the course of one day. When extremely large amounts of salt are eaten, must of it never reaches the blood. In such a case, water is drawn into the intestinal tract and causes diarrhea and consequent loss. During starvation the body holds on to its mineral supply tenaciously. In the same way potassium is either held back or excreted, depending on the amount supplied in the diet.

Minerals as carriers of harmful substances. Minerals are tremendously important in keeping the blood near the point of neutrality, never acid nor alkaline. They are also important in combining with acids and alkalis, which must be carried in the blood and body fluids. For example, if oranges are eaten, citric acid passes directly into the blood. Since the blood must remain neutral, this acid combines with sodium to form a neutral salt, *sodium citrate.*

During vigorous exercise lactic acid is produced by the muscles from the breakdown of sugar. In the recovery period this acid is carried to the liver, where it is changed to glycogen. Since it cannot circulate in the blood as an acid, it combines

with sodium or perhaps potassium to form one of the neutral salts, *sodium lactate* or *potassium lactate.*

If you have ever fainted, someone probably gave you ammonia to smell. Ammonia also occurs in the body and is an alkali. It is formed from amino acids by enzymes in the kidneys. Free ammonia would cause the urine to be so alkaline that the cells of the kidneys might be damaged. For this reason, ammonia combines with chlorine to form a harmless neutral salt, *ammonium chloride.*

Sodium and chlorine are both lost daily in the urine. They are not often excreted together as sodium chloride, which is the same as table salt. The larger amounts are carriers of acids and alkalis which must be thrown off from the body, but which cannot be carried alone in either blood or urine; therefore, salt is usually excreted as a protection to the kidney and bladder tissues, instead of as a waste product.

Other functions of sodium, potassium, and chlorine. These minerals are found in every cell of the body. Sodium and potassium, together with calcium and magnesium, influence the amount of water held in the cells. They help attract chemical substances into and out of the cells. They aid the cell walls in choosing what materials may pass into the cell and what must be kept out. They influence the secretion of glands.

These three minerals are important in sending messages through the nervous system. They help set up conditions responsible for the irritability and contractility of muscle tissue. Chlorine also helps to maintain in the body the amount of water essential to life processes. Chlorine is used in forming hydrochloric acid in the stomach. As we have seen, this acid is necessary for normal digestion of protein and the solubility of many minerals so that they may be absorbed into the blood.

In cases of extremely severe vomiting, as in intestinal ob-

struction, death may result in a few hours because of the loss of chlorine. The chlorine loss is indirectly due to the loss of hydrochloric acid from the stomach. Since the hydrochloric acid is lost in the vomitus, more is continually formed from the chlorine in the blood and again lost. Death occurs when the chlorine supply of the body is too greatly decreased. In such a case, life can be saved if ordinary saline (salt) solution, supplying chlorine, is injected into the blood.

Deficiency of sodium, potassium, and chlorine. When the diet lacks these minerals, the body retains those already eaten so efficiently that a deficiency can hardly be produced.

A partial lack of sodium in the diet of experimental animals causes a slowing of growth. Appetite is interfered with. Excess carbohydrate foods in the body cannot be changed into fat. Such animals become extremely thin. Although sufficient raw materials may be given to make the amino acids which can be synthesized, without sodium the synthesis of protein cannot take place, and muscles become shrunken in size. Ulcers often occur in the eyes, and total blindness may result. The elimination of waste is slowed up, and the stomach and intestines of sodium-deficient animals are extended with gas. Almost all such animals show infections of the lungs.

Potassium occurs so widely in foods that it is almost impossible to prepare a diet adequate in other respects and yet low enough in potassium to produce a deficiency. Even a partial deficiency, however, leads to slow growth, constipation, and a type of nervous ailment typified by extreme alertness and sleeplessness. In potassium-deficient animals, the heart beats slowly and irregularly, and the heart muscles are damaged. The kidneys become enlarged and increase in weight. The bones are fragile and retarded in growth.

When animals' diets partially lack chlorine, growth is again abnormally slow. The animals lose their hair. They are very

easily frightened and become apprehensive. When sodium and chlorine are both deficient at one time, internal hemorrhages take place, and the ears, nose, mouth, and paws become bloody.

When people lack salt. Under normal conditions, a healthy person who eats a reasonably varied diet runs little risk of a deficiency of sodium and chloride. In extremely hot weather, however, particularly if the air is dry, so much salt may be lost through perspiration that death may result. Death due to salt deficiency occurred during the first years of work at Hoover Dam and in other engineering projects on the desert. In milder forms, a lack of salt causes heat cramps, or heat stroke. This condition is common among people who work in furnace rooms, in boiler rooms, and in mines where the temperature is unusually high.

Heat stroke is accompanied by nausea, dizziness, general exhaustion, and muscular cramps in the legs, back, and abdomen. Without salt, the more water drunk, the worse the condition becomes. Men working under conditions of extremely dry heat are now supplied with salt tablets and advised to take one with each drink of water.

Probably every person has experienced hot-weather fatigue. Such fatigue is thought to be largely due to the loss of salt through perspiration. Work or exercise increases perspiration, results in greater losses of salt and causes the fatigue to become more intense.

During very hot weather salty foods such as salted peanuts, popcorn, or soybeans, salty cheeses, or potato chips should be kept near the drinking water. At least one well-salted food should be served with each meal during hot weather. In addition, the person who perspires freely and must work in the heat (as a farmer pitching hay) is wise to take a pinch of salt with each glass of water he drinks.

Potassium deficiency in people. Until recently there appeared to be little likelihood of deficiencies of potassium in humans. The inactivity of the intestinal tract in animals, leading to constipation and gas formation, caused this assumption to be questioned. Therefore, a group of nineteen children were fed diets low in potassium. All developed severe constipation.

Whole-grain breads and cereals and black molasses are extremely rich in potassium. In the process of refining grains, however, three fourths of the potassium is lost. White sugar contains none. The extent to which refined foods are eaten indicates that a lack of potassium may be one of the causes of the widespread constipation in the country.

The recommendations of faddists. Certain food faddists often recommend the use of a so-called vegetable salt, which usually sells at about one dollar a pound. The name and price would imply that this salt actually contains the minerals extracted from natural foods, but analysis has shown that the product is 80 per cent ordinary salt to which ground, dried vegetables have been added. It offers no advantage over ordinary salt, particularly when the price is considered.

Other faddists warn people against the use of salt, saying that it will cause hardening of the arteries. There is no scientific evidence that this statement is true. In severe diseases of the heart or kidneys, urine excretion is so abnormal that salt is sometimes held in the body. In these cases additional salt is not needed, and the physician will ask his patient to avoid salt. Since normal people have a daily loss of salt, they are unwise indeed to restrict their salt intake.

Daily requirements. The amount of salt needed by the body varies with other components of the diet. For example, when large amounts of vegetables are eaten, much sodium is lost in the urine. The need for salt is therefore increased. For this

reason, vegetarians are likely to be deficient in salt when the weather is not hot.

Under normal circumstances about a teaspoonful of salt used daily as seasoning is sufficient to supply the body needs. Except in the diet of a small baby this amount of salt is usually obtained. If water in which salted vegetables have been cooked is given the infant to drink, its salt needs will be supplied.

Except during hot weather, taste should be your guide as to how much salt to eat. You must realize, however, that salt is essential to health; use it generously rather than sparingly.

The ordinary diet usually supplies from 2 to 3 grams of potassium daily. During the period of growth from infancy until the late teens, large amounts of potassium are retained in the body. Even during this time, if the diet is adequate in all other respects and only natural foods are eaten, the intake of potassium need be given little attention.

Case History

K. B. was a handsome chap in his middle-thirties, sufficiently overweight so that he suffered unduly during hot weather. He had only taken the construction job at Hoover Dam, because work was hard to get during the depression, and the pay was especially good due to the danger. He, and dozens of other men, worked swinging on ropes and scaling the abutments down to solid rock. Boulders, loosened by workers above, rolled dangerously near him and the canyon dropped for hundreds of frightening feet below. The air, so thick with dust that he could hardly breathe, was motionless and stifling in the narrow canyon, and the temperature sometimes reached 130° that August of 1933, the hottest summer in years. Even during the night, the thermometer did not drop below 100°, and K. B. could sleep but little and then only when he wrapped a wet towel around his head.

K. B. found it was almost impossible to eat in such heat. For days his only breakfast had been chilled fruits and fruit juices. By noon the meat in the sandwiches, packed only that morning,

had started to spoil; he threw the sandwiches away and ate the apples, oranges, and bananas, so hot that they tasted cooked. At night, he was too tired to eat much besides numerous helpings of ice cream and quarts of lemonade and ice tea.

Each day he felt worse. The fatigue became almost unbearable; severe cramps occurred in his legs and abdomen. One day, he felt particularly ill. His thirst was extreme but each time he drank water he vomited. He stopped working, and since there was no shade he climbed under a station wagon and lay there. When the men stopped work that afternoon they found him, dead.

Topics for Discussion

1. What harm can be done by food faddists who warn people not to eat salt?
2. Why is it that all natural foods contain vitamins and minerals?
3. Food racketeers often offer products rich in potassium for sale at a high price. Are such products worth buying? Give reasons for your answer.
4. What kinds of food are usually eaten during extremely hot weather? Does the uninformed person usually increase or decrease his salt intake at this time?

Chapter 33

THE TRACE MINERALS

Ashes from foods contain elements spoken of as the *trace minerals*. Although little is known of them, it appears that some are of great importance to health. They occur in such small amounts that the chemist is unable to determine their quantity by direct analysis.

When food ash is heated electrically until red hot, each trace mineral gives off a definite series of colors. These colors can be photographed by an instrument known as the *spectrograph*. The study of such photographs shows which minerals are present in the food in question.

Magnesium. Magnesium is an important compound of chlorophyll, the green coloring matter of plants. It is to the life of the plant what iron is to human blood. The best food sources of magnesium are green leaves. Nuts, beans, and peas also contain generous amounts of magnesium. Unmilled grains contain from three to five times as much of this mineral as the corresponding refined products.

So much magnesium salt was found in the springs at Epsom, England, that the name of Epsom was given to the well-known cathartic. Its action is due to the fact that magnesium salts attract water into the intestinal tract, thus causing the food mass to increase in volume and to become unusually liquid. Magnesium in the small amounts found in foods has no such laxative action.

When magnesium is not supplied in the diet of experimental animals, they sicken and die. The hearts become abnormal

and beat with extreme rapidity. The blood vessels expand and cause low blood pressure. The animals are extremely irritable. Slight noises, such as the starting of an electric fan or the turning on of a water faucet near by, cause the animals to go into convulsions which are often fatal. Magnesium deficiency produced experimentally in animals resembles certain types of insanity more nearly than that produced by any other means. In a few cases, the blood of people suffering from extreme irritability has been found to be low in magnesium.

Magnesium is known to be important as a co-enzyme, a substance which is necessary before certain enzymes in our bodies can do their work. There is evidence that this mineral assists in using body fat. Magnesium is necessary for normal growth. Experimental work indicates that it is important in nerve action and relaxation of muscle tissues.

It is not impossible that extreme irritability and even some types of insanity may be connected with the lack of magnesium in the diet. People who have long lived on refined foods and have neglected to eat green vegetables might easily be deficient in this mineral.

Aluminum. Aluminum is found distributed in various parts of the human body and in the bodies of animals which have never eaten foods prepared in aluminum utensils. Whether its presence is accidental or is necessary to health has not yet been determined.

Because of trade war and resultant propaganda, there is a popular belief that aluminum is injurious and may even cause cancer. For this reason extensive studies have been made of the possibility of aluminum poisoning.

Large amounts of aluminum have been fed to experimental animals. It is found to be absorbed very little through the intestinal wall. Quantities, thousands of times greater than amounts likely to be consumed by humans, have caused no

harm. Even large amounts of aluminum, injected directly into the veins of animals, have caused no damage. Growth is not retarded. No signs of disease or injury were found when the tissues of all organs were carefully studied under the microscope.

As early as 1907, President Theodore Roosevelt appointed a board of scientific experts to investigate the alleged harmful effects of aluminum. After seven years of research, the board reported that aluminum was found to exert no deleterious action injurious to health.

A similar investigation was undertaken under the auspices of the Medical Research Council in England. This council reported that though acid fruits and vegetables were cooked for hours in aluminum utensils, so little aluminum was found in the food that it was almost impossible to detect its presence by the most delicate chemical means. When strong acids themselves were boiled in aluminum utensils, only slight traces of aluminum were found dissolved in the acids.

A publication of the United States Bureau of Standards states that there is no evidence to indicate that aluminum cooking utensils represent any potential danger to health. It further states that this substance may be found to be necessary to health itself.

Zinc. Zinc is necessary to the health of experimental animals and in all probability to that of human beings. It is present in human tissues, especially in the thyroid. It has been found to be one of the constituents of *insulin,* which is necessary in the normal storage of glycogen. The liver of an infant is particularly rich in zinc, containing about three times that of adult liver.

The liver of young animals contains a larger amount of zinc than that of older animals. Calves' liver therefore is a better source of zinc than beef liver. Human milk and the milk of

various animals contain zinc. The first flow of milk is especially rich. Though zinc occurs rather widely in foods, perhaps the most dependable source is milk.

Zinc deficiency, produced in experimental animals, results in slowed growth. Hair or fur does not develop normally and is quickly lost. In animals the lack of zinc appears to interfere with the absorption of food through the intestinal wall. The animals become extremely thin and emaciated.

Until more is known concerning the human needs of zinc, it is well to drink a quart of milk daily and to eat liver one or two times each week to supply this mineral.

Cobalt. Like zinc, cobalt appears to be essential to the health of both animals and humans.

A disease of cattle and sheep, which caused the death of thousands of animals, occurred in the Southern Gulf States and in Australia. It is characterized by severe anemia, wasting, listlessness, and emaciation. The animals quickly recovered when given cobalt. The cause of this disease was found to be the lack of cobalt in the soil and hence in grasses grown on the soil.

Cobalt is found in small amounts in most of the organs of the human body. It appears to be particularly related to the development of red corpuscles. In persistent anemias in people, the giving of cobalt in addition to iron and copper has brought about beneficial results. It would be interesting to know if the anemia which occurs in people eating foods grown on the cobalt-deficient soil of the Gulf States could be relieved by the addition of cobalt to the diet.

Little is known of the food sources of cobalt. Since larger amounts of this mineral occur in liver than in other tissues, liver appears to be the most dependable food supply.

Manganese. It is known that manganese is necessary to human health. Its exact action in the body is little understood.

It is particularly concentrated in the liver, pancreas, and adrenal glands. It passes from the mother's blood into that of the child and appears to be much more concentrated in the infant than in the human at any other stage of life.

Lack of manganese in female animals appears to interfere with the maternal instinct. Rats on manganese-deficient diets will not suckle their young. Normal mother rats readily adopt healthy young. In a study in which manganese-free baby rats were given to normal foster mothers, only seven out of one hundred and seven young animals were adopted. One third of the young of manganese-deficient mothers were born dead.

In chickens, the lack of manganese in the diet during growth causes a deformity of the leg bones. Eggs of hens fed a manganese-free diet do not hatch.

Dr. Amy Daniel of the University of Iowa has studied manganese retention in children. She found that the larger the amount given in the diet, the greater the quantity retained in the body. This fact indicates that the larger amounts were of value to health.

Manganese is found in green leaves and is richly supplied in peas and beets. Unmilled or whole-grain breads and cereals contain about six times the quantity found in the refined products. It is very probable that the manganese needs of the body would be supplied if only unrefined foods were eaten.

Fluorine. Though fluorine is found in many tissues of the body, it cannot be considered essential to health. Fluorine combines chemically with calcium and is therefore laid down in the bones and teeth.

If too much fluorine is obtained during the period when the teeth are forming, it causes a severely abnormal condition known as *mottled teeth*. In parts of twenty different states of this country, fluorine occurs in drinking water in sufficient quantities to cause mottled teeth. Such teeth are extremely

ugly and vary, depending on the amount of fluorine ingested, from yellow to dark brown, as do those of a person who chews tobacco. These teeth are also structurally weak and deteriorate early in life.

Where fluorine occurs in drinking water, such water should not be used even for cooking. In certain sections of the country, all the water available is so contaminated with fluorine that it is almost impossible to avoid it. A process has been developed by the Arizona Agriculture Experimental Station for removing fluorine from water by filtering it through ground bone.

Although fluorine occurs in fruits and vegetables grown in such regions, these foods do not contain large enough quantities to be harmful. Vegetables sprayed with insecticides which contain fluorine produced mottled teeth in rats and may be harmful to humans. It is recommended that the sale of such insecticides be controlled by the government.

Other trace minerals. There are a number of trace minerals which can be either harmful or valuable to health depending on the amount obtained.

Tin. Tin is found in many human tissues, especially in the liver, brain, and thyroid gland. Considerable research has been done on the tin content of canned foods and its effect on the body. It has been found that even when acid food is allowed to stand open in tin cans before it is eaten, the small quantities of tin consumed appear to have no harmful effects on health.

Arsenic. Although arsenic is well known as a drug and as a poison, it too may be an important element in human nutrition. Relatively large amounts of arsenic are found in the liver. The concentration in the blood varies depending upon glandular activity. Just how arsenic affects human physiology is not known.

Bromine. Bromine, like arsenic, is best known as a drug and a poison, and yet it is always in human blood. In a certain type of insanity known as *manic depressive,* the amount of bromine in the blood falls to one half the normal quantity and increases only upon recovery from the disease. The section of the pituitary gland which profoundly affects growth contains ten times more bromine than any other part of the body. The bromine content of the tissues is high in early life and decreases with age. This meager knowledge indicates that bromine is essential to health.

Nickel. Nickel is found in human tissue, particularly in the pancreas. Its function, if any, is unknown.

Silver. Silver occurs in the blood, liver, sex glands, heart, spleen, kidneys, and especially the thyroid and tonsils. Its function is unknown.

A great deal is still to be learned about the exact role of trace minerals in human nutrition. Only future research can tell us the best food sources of each. In the meantime, a diet abundant in milk, glandular meats, fruits, vegetables, and unrefined breads and cereals will in all likelihood fulfill our needs in this respect.

Topics for Discussion

1. Give all the reasons you can why liver should be eaten at least once or twice each week. Would liverwurst sandwiches make a good luncheon food? Why?
2. Make a list of every element which is partly or wholly lost in the refining of grains and sugar. Examine the labels on fortified white breads. How many body requirements have been removed in refining which are not replaced by fortification?

PART FOUR

APPLICATION OF NUTRITIONAL KNOWLEDGE

Chapter 34

YOUR NEED FOR LIQUIDS

About three fourths of the weight of the body is water. Next to oxygen the need for water is greater than any other requirement. Water is the transportation system by which foods and other valuable substances are carried to the cells and by which wastes are removed. All body activities take place in water. It is a lubricant for all moving parts. It makes up 92 per cent of the blood and about 98 per cent of the saliva, bile, and gastric, intestinal, and pancreatic juices. It is the substance through which body temperature is controlled.

Although a human can live for a number of weeks without food, death results in from sixty to eighty hours if he is deprived of water. At a comfortable temperature, the normal adult needs about 2 or 3 quarts of liquid daily. This requirement is of such tremendous importance that no one with the proper regard for his health would ever neglect it.

Sources of water. Most liquids contain 90 or more per cent of water. Such amounts are found in milk, milk drinks, soups, fruit and vegetable juices, and fruit ades. Foods like gelatin and ice cream, which are largely water, are converted to liquid form in the stomach.

The table on page 358 gives the approximate percentage of water in our average foods.

Notice that vegetables sometimes contain more water than milk does.

Excessive water intake. When excessive quantities of water are given to experimental animals through a stomach tube,

nausea, vomiting, frequent urination, and diarrhea result. If the forcing of excessive water is continued, the animals develop tremor, restlessness, and finally convulsions. The symptoms are the same as those resulting from a deficiency of salt, since they are caused by salt having been washed out of the body.

FOOD	PER CENT WATER
Bouillons	96
Bread	30–45
Cereals (uncooked)	10
Cheese (cottage)	72
Cheeses (other than cottage)	30–50
Fish	50–80
Flour	10–12
Fruits (fresh or canned)	75–90
Meats (unless extremely fat)	50–70
Milk (whole)	88
Milk (skim)	92
Nuts	8–5
Soups	85
Vegetables	75–95

Similarly, in uncontrolled diabetes (a disease where thirst is intense and excessive water is drunk) so much thiamin is washed out of the tissues that neuritis and other thiamin deficiencies very quickly appear.

In the same way, if a person drinks excessive quantities of water, believing large amounts to be advisable, the minerals and vitamins which dissolve readily in water are needlessly lost. On the other hand, the person, who depends upon thirst for his water intake, will probably never drink too much water.

Other liquids versus water. Since a person can pleasantly drink only a certain amount of liquids, those fluids which have the greatest health value should be chosen. For example, a quart of milk offers far more of value than the 3½ cups of water it contains. Two or more glasses of fruit juices supply about a pint of water, as well as minerals and vitamins. The

ideal procedure would be to drink milk or fruit juices instead of water, whenever thirsty.

In cases where a limited income makes it impossible to purchase sufficient fruit juices, the drinking of water in which vegetables have been cooked offers far greater value than ordinary water. Vegetable-cooking water is sometimes as rich in ascorbic acid as is orange juice. Such cooking water also contains vitamins of the B complex and quantities of minerals. If all water in which vegetables have been cooked is poured together into a container and kept in the refrigerator, the taste of no one vegetable will be too prominent to make such water unpalatable. Anyone who really desires to have health can soon learn to enjoy such a substitute for drinking water.

Fulfilling your liquid requirement. The amount of foods eaten by a normal adult in the course of a day usually supplies about 3 cups of water. If a quart of milk and at least two glasses of either fruit juices or water in which vegetables have been cooked are drunk, this amount of fluid, together with other liquids you may desire to take, will usually fulfill your daily needs for water.

By all means realize that your fluid intake is of tremendous importance. At the same time, do not crowd out more valuable liquids because of a conviction that large amounts of *water* should be drunk.

Projects

1. Make a list of everything you have eaten and drunk in twenty-four hours. Calculate the cups of fluid you have obtained. Has your daily requirement of liquid been met?
2. Let us suppose that, on a hot day, a person drank the following: 1 quart of milk; 16 ounces each of orange, tomato, pineapple, and grapefruit juices. From these 3 quarts of fluid, calculate the amounts of all body requirements he would obtain which could not be secured from drinking water.

Topics for Discussion

1. Name as many uses of water in the body as you can. How does the body conserve its water supply?
2. The loss of which requirements would be increased if excessive water is drunk? Under what conditions should these requirements be supplied more abundantly in the diet?
3. How could the giving of large quantities of water during an illness influence the need for other body requirements? Is this influence taken into consideration in feeding persons who are ill? What recommendations would you make for feeding an ill person whose fluid intake must be excessive?
4. Which vitamins and minerals might be obtained by drinking the water in which vegetables have been cooked?

Chapter 35

PLANNING THE FAMILY'S HEALTH

The knowledge of nutrition is of little value unless it is applied to your life and to the life of each member of your family. The purpose of the study of nutrition is to learn how to build the highest degree of health possible. Only through the constant application of nutritional findings can such a degree of health be attained.

The production of disease. If you have conducted an animal experiment in the course of this study, you have probably watched animals, whose diet is adequate in every respect except one, gradually change from health to disease. Usually, as a class watches this change take place, there are many expressions of sympathy for the animals. It is true, the animals lose weight. Their eyes become dull, their coats grow shaggy, and their posture is poor. Their vitality is gone. Those students who show sympathy often have the same characteristics: their eyes are dull; their posture is poor; their hair lacks gloss; their vitality is not up to par. The animals' diet is adequate except in one respect. The students' diet is usually inadequate in many respects.

Before starting to conduct animal experiments we know that, if an essential element is omitted, disease will be produced. Disease is produced in the same manner in humans. Day after day, you are doing one of two things: either building your health or producing disease in yourself. If you watch people eating in restaurants, at lunch counters, and in drug stores, you will see either health being built or disease being produced, just as surely as it is during animal experiments.

In every experimental study there is a group of positive controls, animals which have a diet adequate in all respects. This diet is adequate simply because it supplies all of the body needs. Similarly, your diet can be adequate only when it meets every need of your body.

Serve nutritious foods when you entertain: fruit punch, apricot ice cream, fruit, and wafers.

Your body requirements. Every person, regardless of age or degree of health, needs adequate amounts of liquids, vitamins, minerals, proteins, fats, and carbohydrates. Since certain foods are the best sources of various requirements, a summary of these foods will give you the basis of the day's dietary:

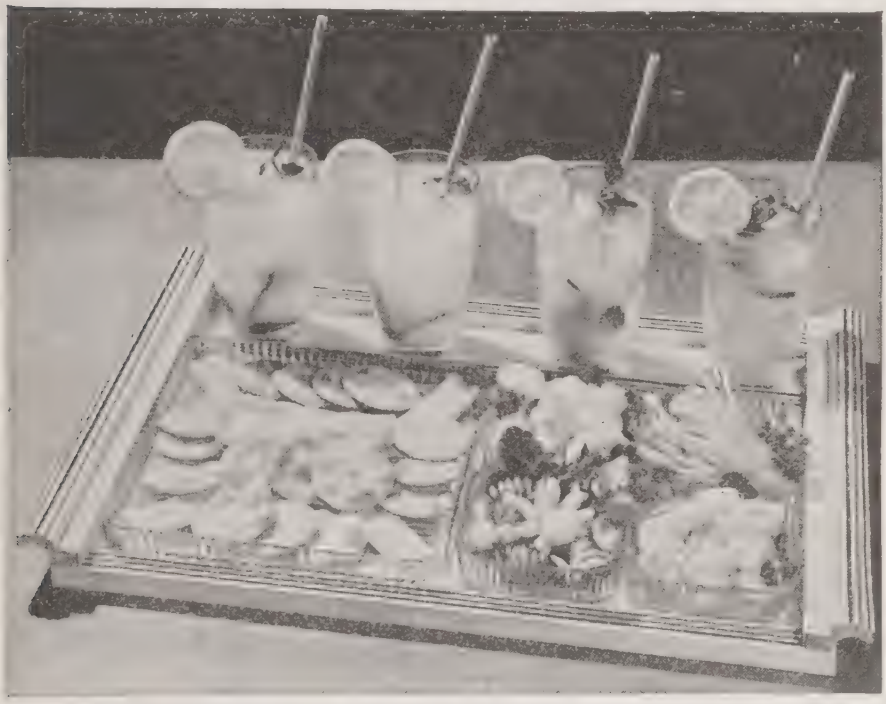
1. One quart of milk, either whole or skimmed, or buttermilk.
2. Wheat germ or yeast; blackstrap molasses, and whole-grain breads and cereals to the exclusion of all others.

3. Some form of fish-liver oil; at least a tablespoonful of cod-liver oil or its equivalent in other fish-liver oils or capsules.

4. Eight ounces of orange, or grapefruit, or 16 ounces of tomato juice; at least one fresh salad; some vegetable eaten raw.

5. At least a teaspoonful of iodized salt.

6. One serving of cheese.



Serve nutritious foods when you entertain: lemonade with mint, cheese crackers, carrot sticks, celery rings, radishes, and pickled cauliflower and parsley.

7. One serving of meat, fowl, fish, eggs, or a meat substitute such as baked navy beans or soybeans, or 100 per cent whole-grain macaroni, noodles, or spaghetti. Liver, heart, or other glandular meats should be served at least once each week. Some type of sea food or ocean fish should be eaten once a week.

8. Three or more green or yellow vegetables; one serving daily of a deep-green leafy vegetable, such as kale, collards, chard, turnip or beet greens, or watercress.

9. Three or more fruits besides the fruit juice. Colored fruits should be chosen more often than colorless ones.

10. One teaspoonful or more of vegetable oil.

Checking the body requirements. Now that we have the daily program outlined, let us analyze it in order to check the results. It must stand the test: *every body requirement must be met.*

1. *Vitamin A:* fish-liver oil, colored fruits and vegetables, cheese, and egg yolk. Cream, butter, and liver augment the vitamin-A intake.

2. *Vitamin-B complex:* wheat germ or yeast; blackstrap molasses; whole-grain breads and cereals.

3. *Ascorbic acid:* orange, grapefruit, or tomato juice; salads; raw vegetables and fruits.

4. *Vitamin D:* fish-liver oil, vitamin-D milk if it is used.

5. *Vitamin E:* wheat germ; green, leafy vegetable; vegetable oil.

6. *Riboflavin:* milk, cheese, egg, meat, yeast if it is used.

7. *Pyridoxin:* blackstrap molasses, vegetable oil, yeast, wheat germ.

8. *Niacin:* meat, especially liver; eggs, yeast, wheat germ.

9. *Vitamin K:* green leafy vegetables, blackstrap molasses.

10. *Calcium:* milk and cheese; green leafy vegetables.

11. *Phosphorus:* milk, cheese, meat, fish, egg, whole-grain breads and cereals.

12. *Iron:* wheat germ, blackstrap molasses, egg yolk, red meats, whole-grain breads and cereals, green vegetables.

13. *Copper:* egg yolk, blackstrap molasses, vegetables, sea foods.

14. *Trace minerals:* green vegetables, whole-grain breads, milk, liver.

15. *Unsaturated fatty acids:* vegetable oil.

16. *Bulk:* fruits, vegetables, whole-grain breads and cereals.

17. *Liquids:* milk, fruit juices, soups, and other food liquids; any amount of water you may wish to drink.

18. *Sodium, chlorine, and iodine:* iodized salt.

This simplified method of checking is only superficial. If individual needs are to be met, the amounts of each require-

ment must be calculated on the basis of each person's weight, age, and activity.

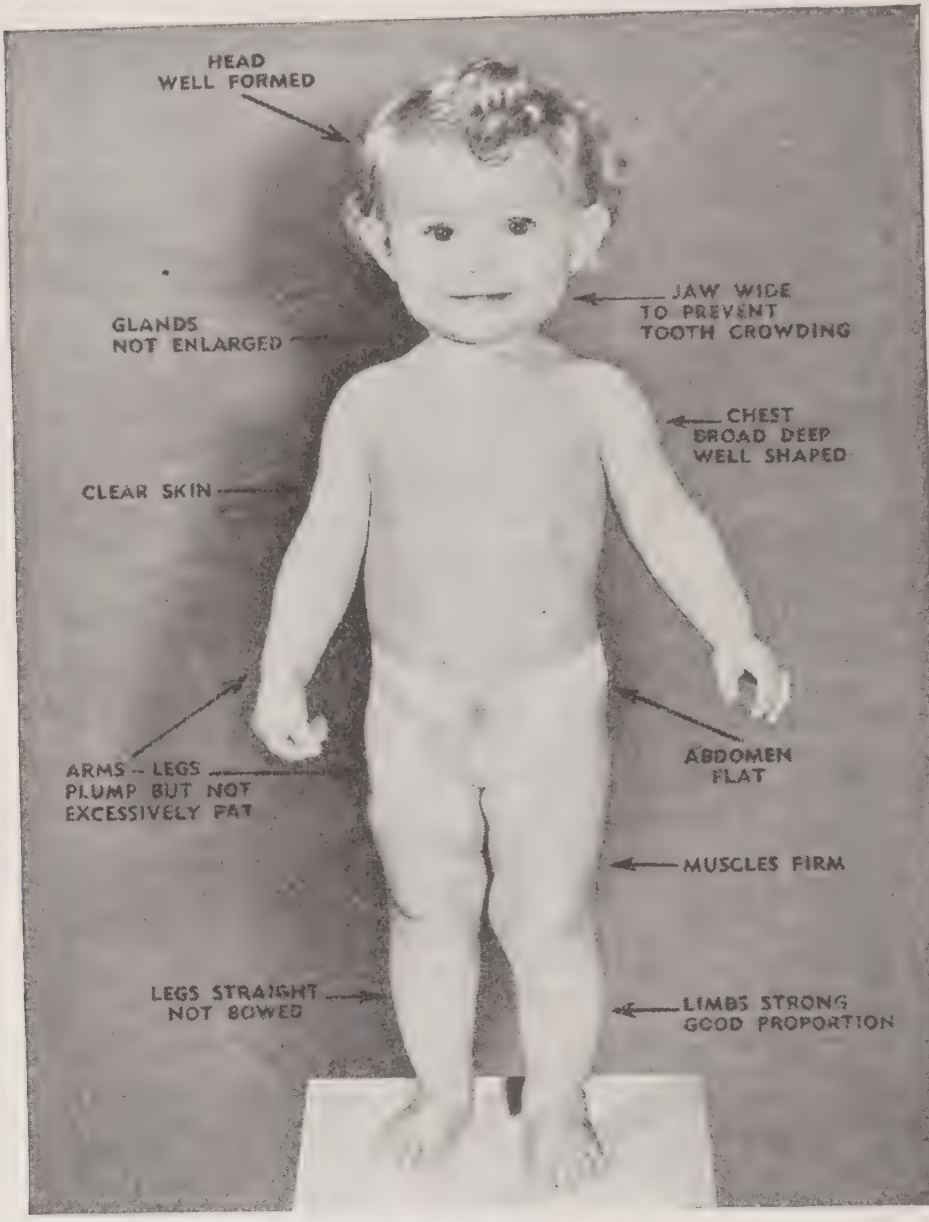
Basic daily menus. Your next problem is to get these foods worked into daily menus:

Breakfast:	orange, grapefruit, or tomato juice, 8 oz.
	fruit, colored
	wheat-germ cereal and milk or cream
	egg, if desired
	whole-grain bread
	milk or milk drink
Lunch:	egg, if none for breakfast; or cheese or meat, if desired
	1 to 3 vegetables, or a salad
	milk
	whole-grain bread and butter
	fruit
3:30	fruit or milk sweetened with blackstrap molasses
Dinner:	soup, if desired
	meat, or meat substitute
	2 or 3 vegetables
	salad
	whole-grain bread and butter
	milk
	fruit
	cheese and nuts, if desired
At bedtime:	milk or hot-milk drink; 1 tablespoonful of blackstrap molasses

Such a dietary is merely a suggested outline, but it can be used as a basis in planning menus for almost any person regardless of age or degree of health.

Now let us see what variations must be kept in mind in planning the health of people of different ages and under various conditions.

Planning the baby's health. Since the feeding of most babies is supervised by private physicians or public clinics, only a few of the more important points need be stressed here.



The normal development of the body is an important general index or guide to optimal growth and health. Early and regular use of this, or a similar diagram, on which deviations from the normal may be noted, can be of help to the mother in guarding against or correcting physical defects in her own baby.

Orange juice, some form of fish-liver oil, and a dependable source of vitamin-B complex should be started as early in life as possible. Concentrates of vitamin-B complex from rice polishing, wheat germ, or yeast may be purchased. The baby's drinking water should be water in which vegetables have been cooked and seasoned with iodized salt. If the baby is artificially fed, blackstrap molasses should be used in the formula to replace at least part of refined cane syrup or other forms of carbohydrates usually used. The unrefined molasses supplies iron and the heat-stable vitamins of the B complex, all of which are neglected in present-day baby feeding.

Cereals should be started when the baby is five or six months old. Even at this age neither refined cereals nor those which need be cooked longer than ten minutes should be used. Wheat germ should be the cereal served most often.

Vegetables and fruits should be started by the sixth month. They should be chosen for their yellow and green color. At this age, liver and other glandular meats, such as kidney and sweetbreads, may gradually be added to the diet. By the sixth month a soft-curd cottage cheese should be given daily in case an entire quart of milk is not always consumed. The present custom of preparing such desserts as custards, junkets, and puddings for babies and small children should be discarded in favor of yellow fruits.

Refined sugar should not be given a baby in any form. Every effort should be made to prevent anyone from giving the child candy. Some grandparents would seem to be not as interested in building the child's health as in buying its affection at a cheap price.

Since the baby's stomach is extremely small, space should never be wasted by giving refined cereals, breads, crackers, cookies, or any other food which cannot build health.

Planning the child's health. A period of neglect usually begins by the time a child is two or three years old. The monthly trips to the physician may have stopped and the mother frequently does not realize the importance of continuing such foods as cod-liver oil, orange juice, and other foods which are essential. So little vitamin-B complex is generally supplied that lack of appetite is almost the rule rather than the exception. Sweets, desserts, and refined foods are carelessly allowed to creep into the diet. A period begins in which disease is produced as surely as it is in inadequately fed laboratory animals.

Aside from the basic day's dietary there is little further to recommend. Not one of the good habits started in babyhood should be stopped. Some form of fish-liver oil should be given both summer and winter. Wheat germ, whole-grain breads and cereals, glandular meats, and generous amounts of vegetables and fruits should be continued. Fruits should always be used to the exclusion of other desserts.

At this period, a wider variety of foods may be introduced into the menus. Every new food offers a strange taste which the child must slowly learn to enjoy. In introducing any new food, only half a teaspoonful should be given at the beginning of a meal. No child or adult should be expected to eat large amounts of a food which is strange to him.

Since growing children are particularly active, midmeals should be emphasized. Carbohydrate foods such as bananas, other fresh fruits, dried fruits, whole-grain bread sandwiches, or cookies or gingerbread made of wheat germ and black molasses make excellent midmeals.

Planning the health of the adolescent. From thirteen years and on, there comes a rapid spurt of growth which causes the amounts of all bodily requirements to be greatly increased. At this time, it is extremely important to have cheese daily in addition to milk. The need for the vitamins of the B complex is

especially increased, particularly in boys. Unless vitamin-D milk is used, fish-liver oil, which may be supplied by tasteless capsules or tablets, should be taken daily.

In planning a girl's health, particular emphasis must be placed on supplying adequate iron. One tablespoonful of black molasses may be added advantageously to each glass of milk she drinks. It is especially important for her to eat light midmeals. If the diet is kept wholly adequate during the years of adolescence, the abnormalities so prevalent at this age, such as anemia, awkwardness, tooth decay, and skin eruptions, can be avoided.

Planning your mother's health. For years your mother has probably annoyed you by insisting that you eat this food and that. Let us turn the tables and check up on her diet. She has been warned by physicians, magazine articles, and lecturers to feed her children correctly; yet almost nothing has been told her about what she herself should eat. If she is to keep free from unnecessary fatigue, to have the calm, even disposition necessary to run a well-organized household, and to maintain the courage to tackle her problems, her diet must be adequate.

Does she drink enough milk? Does she get a dependable source of the vitamin-B complex? Is she drinking too much coffee? Does her color indicate that she needs more iron? Does she get iodine daily?

Sometimes it is difficult to make a mother build up her own health. If your mother is evasive in this respect, use a bit of psychology (she has probably used it with you often enough). The chances are she will do anything for you. If you insist upon the correct foods for yourself, your mother will eat these same health-giving foods with you, because there is little likelihood of her cooking separate meals merely to cater to her own wishes.

Planning your father's health. Let us check up on dad. He has much responsibility, and his work is probably difficult and nerve racking. He needs energy, stamina, and perseverance,—qualities closely related to the foods he eats.

Since men need much larger amounts of vitamin-B complex than women do, make sure that your father's diet meets his daily requirement in this respect. Get him to eat wheat germ. See that only 100 per cent whole-grain breads and cereals are served. You might make a wager with him that if he takes two heaping tablespoonfuls of powdered yeast stirred in fruit juices every day for a week, he will feel better. You are sure to win.

Since a man's work is frequently nerve racking, his calcium intake should be high. Unless your father gets into the sunshine at least once a week, he needs some form of vitamin D in order that calcium may be absorbed efficiently. Magnesium found in green vegetables also appears to be important in relaxing the nerves. As in any other case, if your father is to be healthy, every body requirement must be met.

Grandmother and grandfather. If you tackle the task of improving the diets of your grandparents, the chances are that you will find that you have a real problem on your hands. Older people take little exercise and therefore cannot eat a large quantity of food. Unless there is definite planning, the diet of a person over fifty-five years old is usually appallingly deficient in almost every respect. A deficiency of vitamin-B complex, causing constipation, gas, and indigestion, is almost the rule rather than the exception. Many foods are avoided for fear of making these conditions worse; the already defective digestion and absorption are aggravated by the use of cathartics. The B-complex deficiency must be overcome before other requirements may be well absorbed into the blood. How long has it

been since your grandparents have taken a sunbath? Have they ever taken cod-liver oil? Do they bruise easily?

If the diet of older people is to be adequate, every bite of food eaten should be chosen because of its capacity to build health. Though smaller amounts of food will be used, the same basic dietary holds good.

Your responsibility to others. When you are tired or nervous or not feeling up to par, you are likely to be grouchy and unpleasant to live with. If you allow yourself to become actually ill, you increase the worries, the expense, and the work of those who love you. For these reasons, you owe it to your family to build the very best health which it is possible for you to build. Your health is not your own. The person who neglects to build his health is not playing fair.

Your parents' responsibility to you. Many sons and daughters have to help support their parents. The expense of avoidable illness each year, paid for by the children, runs into millions of dollars. Even if the parents are always self-supporting, needless illness on their part demands time, worry, and energy from the children.

Are your parents producing disease which may some day cost you money and energy? Are you doing everything you can to help them avoid such illness? Just as you owe it to them to build the best health possible, so do they owe the same to you.

Projects

1. Check the diet of every member of your family, following the illustration of planned health on page 470 or, better still, urge the older members of your family to check their own diets. Compare the actual intake of each body need to their ideal daily requirements. Which of these are missing or inadequately supplied?

2. Make a list of all the people whom you know who are helping to support other members of their family. Are their expenses made higher because of illness? Could these illnesses possibly have been prevented?
3. Watch people eating in restaurants, lunch counters, and drug stores. How many seem to be doing everything they can to build health? How many appear to be producing disease?
4. Choose the amounts of the foods which are suggested in the basic dietary, together with the menus likely to be eaten in one day by an average person. Check this diet by using the tables on pages 442–465. Are all body requirements met?
5. If possible, observe the diet given to a baby or small child. What improvements could you suggest?

Topics for Discussion

1. Name all the reasons you can why your family owes it to you to build health. Give examples of inconvenience to you when they are careless about building health.
2. What requirements should be especially kept in mind in planning a dietary for the following: a baby; a growing child; an adolescent; an adult man; an adult woman; an elderly person? Why should these particular requirements be especially checked?
3. What problems have you in improving the health of your family? How can these problems be overcome? What suggestions can other members of the class make as to problems which appear to have no solution?

Chapter 36

HEALTH PROBLEMS OF THE HIGH-SCHOOL STUDENT

Students often ask what may be done for their pimples, nervousness, anemia, or some other abnormality. They obviously want one specific thing which will do the trick.

The medical practice of treating a particular irregularity with a particular drug is no doubt responsible for this attitude. For example, quinine may be used for malaria and aspirin for colds. This same attitude has been carried over into nutrition. Since the achieving of full health through planned nutrition is a building process which requires ample supplies of some fifteen vitamins, twenty minerals, fats, carbohydrates, and proteins, it is obvious that increasing the amount of a single requirement can never aid greatly in overcoming any particular abnormality.

No one cause. Let us suppose you suffer unusually from fatigue. We know that something is interfering with your energy production. Perhaps there is not enough hemoglobin to carry sufficient oxygen to allow food to be burned normally; perhaps the heart is beating so slowly that too little oxygen reaches the tissues; perhaps you are eating so few carbohydrates that the glycogen stores are quickly depleted and the sugar supply is low; perhaps a lack of thiamin causes the burning of sugar to be incomplete; perhaps an iodine deficiency allows too little sugar to be burned; perhaps the lack of ascorbic acid, riboflavin, niacin, or several other vitamins is interfering with the production of energy. The fatigue might be caused by the

inefficient burning of fat or the destruction of thiamin by toxins from an infection which you do not know exists.

In short, your fatigue may be due to any one of a dozen or more causes, or a combination of several causes. In like manner, any abnormality such as tooth decay, anemia, poor muscle tone, susceptibility to infection, or any other may have several causes. Therefore, improving the diet in only one respect accomplishes little. Every requirement is needed for the normal function of each cell in the body, and all requirements must be adequately supplied. Almost every abnormality of the body may be due to a lack of any number of body requirements.

Learn to enjoy foods. When the food supply is adequate, the principal reasons for poor health are dislikes for health-building foods. Many people are nervous and irritable and have unpleasant dispositions because of lack of calcium, and yet they say, "I don't like milk." What they are actually saying is, "To me the taste of milk is of greater importance than my health." Such a remark shows the speaker to have a wrong sense of values. He is either unintelligent or indifferent to the value of good health.

One learns to enjoy a new food by eating it repeatedly. You can undoubtedly think of numerous foods which you did not like the first time you tasted them but which you now enjoy. In the same way you can learn to enjoy any food regardless of how unpleasant it seems at first. Perhaps an outstanding example is to be found in the number of children who now sincerely enjoy the taste of cod-liver oil. Dislike of foods labels the person not only as an adolescent but as one who has never traveled. The world traveler knows and delights in the taste of foods of all nations.

If any food can build health, set out to cultivate a taste for it. Expect the taste of any new food to be unpalatable. Take

A box lunch may be both delicious and health-building.

only a bite the first time it is served to you, but continue to taste it every time the opportunity arises. In a short time, you will find that you definitely enjoy this taste.

School lunches. People who carry lunches frequently remark that they can think of nothing to take aside from sandwiches. The following foods are suggested:

1. Milk or a hot-milk drink or cream soup brought in a thermos bottle
2. Raw carrots; other vegetables such as celery, radishes, green pepper, cucumbers, tomatoes, kohlrabi, and raw turnips if desired
3. A large cube of cheese or a carton of cottage cheese
4. Dried apricots
5. Fresh fruits
6. A variety of dried fruits
7. Nuts, particularly peanuts
8. Liver sausage
9. Boiled egg

The first four items should be included in every lunch, day after day, with little or no attempt at variety. The person who wishes to avoid bread because of calories may choose other foods listed and have a pleasant lunch totally without sandwiches.

Breads for sandwiches should always be 100 per cent whole grain. Get acquainted with black Russian bread and sweet Swedish rye as well as Jewish pumpernickel. Lettuce should be added to all sandwiches, and as much butter and mayonnaise as weight permits.

Sandwich filling may be made of almost any food valuable to health, such as meats and fresh green pepper, liver paste, chopped egg and celery, tuna salad, bacon and tomato, avocado, banana and peanut butter, and peanut butter alone.

If the desire is to build health and not to produce disease, there is no place in any school lunch for cake, pie, the usual variety of cookies, white crackers, or jelly and jam sandwiches. If a sweet is desired, an excellent sandwich spread may be made by stirring wheat germ into black molasses or honey until a solid paste is achieved; nuts and raisins may be added. Cookies which contain wheat germ, black molasses, powdered milk, raisins, and nuts are delicious and are valuable in any lunch.

Dried fruits should be the main candy substitute; enough

should be carried to allow some to be eaten in the middle of the morning and the afternoon. Other health-building candy substitutes are salted peanuts or soybeans, and cracker jack made with black molasses. Powdered milk candies are superior to all others.

Many school cafeterias, particularly those supervised by trained home-economics teachers or dietitians, serve excellent meals. Outstanding progress was made when so-called surplus foods, such as unrefined breads and cereal products, and generous amounts of fresh fruits and vegetables were served to school children. There resulted a marked increase in attendance and a soaring of grades. Similarly, the attendance in your school and the standard of grades may be largely due to the efforts of the person managing your cafeteria.

On the other hand, many cafeterias are managed by people who have little or no training in nutrition. Entirely too much emphasis is put on warm lunches, whereas whether a food is hot or cold makes not one iota of difference from the standpoint of building health. Because the budget is often limited, inexpensive refined foods such as white macaroni, noodles, and rice are too frequently served, although the unrefined products could have been had at the same price. Vegetables are often undersupplied and overcooked or they are necessarily kept too long on steam tables. Far too many pies, cakes, jellos, and other sweets are offered. Foods which cannot possibly build health, such as coffee and soft drinks, are sold in quantities. Growing children who know nothing of the needs of their bodies are allowed to choose foods. Drastic changes in policy should take place in this type of cafeteria. Until such changes are made, the students would do well to bring healthful lunches from home.

Skin health. Perhaps the health problem which brings the most unhappiness to the high-school student is that of pimples,

or *acne*. Unfortunately, there are numerous causes of acne, many of which are related to body changes only understood by a physician. For this reason, the boy or girl who suffers from acne should be under the care of a physician whose advice concerning diet should be followed implicitly. The student who understands the relation of nutrition to skin health, however, will co-operate with the physician more heartily than one who expects lotions to bring about a cure, while he eats as he chooses.

In many cases, adolescent acne is complicated by the fact that body requirements are unusually high, due to rapid growth. Therefore, a diet complete in every respect is of the utmost importance. You will remember that when vitamin A is undersupplied, infections frequently result; since acne is an infection of the cells of the lower layer of the skin, this vitamin may need to be increased. Animals lacking any one of the vitamins, riboflavin, pyridoxin, niacin, or pantothenic acid develop skin abnormalities. Also, acne may be the result of poor circulation caused by inadequate thiamin or a lack of iodine. For these reasons, iodine and the vitamins of the B complex may be of particular importance in correcting acne. Ascorbic acid, which is especially valuable in building resistance to infections as well as increasing healing, may need to be supplied in quantities greater than usual. The avoiding of sweets may aid because more nutritious foods must be eaten to satisfy the appetite. Since quantities of nutrients needed for healing are much larger than those required to prevent deficiencies, only a physician who has studied the individual case can know which body requirements should be increased and just how much each should be increased.

You will also remember that dry skin may be caused either by too little vitamin A or by poor circulation due to lack of iodine or of the vitamin-B complex, and that oiliness of skin

may indicate that too little riboflavin or pyridoxin has been obtained.

When the body requirements decrease at maturity, acne may possibly disappear. The idea, however, that the boy or girl will outgrow acne is an unforgivable one, since it inflicts needless mental suffering which may be so great as to alter the personality of the sufferer. Adolescent acne may also leave scars on the skin which mar beauty for many years. On the other hand, there is probably no case of acne which cannot be readily cleared up if the diet is completely adequate.

Suggestions for the athlete. The main point to be stressed in planning a diet for any athlete is that his extreme energy expenditure increases the need for calories and almost all vitamins, particularly those easily lost in perspiration. Unless his health is to suffer, his diet must be unusually good.

Since carbohydrates are more efficiently burned to produce energy than are fats and proteins, the diet should be high in grain products, fruits, and vegetables. Midmeals of dried fruits are recommended. Of all body requirements, the need for vitamin-B complex is particularly increased. Whole-grain bread and cereals and generous amounts of wheat germ should be used. Yeast may be used to advantage.

Many a game has been lost because the best player is home with a cold. Therefore, foods particularly rich in vitamin A and ascorbic acid should be emphasized. Coaches who insist that the athletes have orange juice daily and cod-liver oil in some form have reported fewer broken bones and other serious injuries during the season.

Suggestions for preventing tooth decay. The personal attractiveness of many persons has been wrecked because of rampant tooth decay during the high-school years. All too often, an otherwise winning smile is completely eclipsed by a display of imperfect teeth.

Peanuts are an excellent candy substitute.

Perhaps the greatest single cause of tooth decay is the eating of sugar. A type of bacteria, known as *bacillus acidophilus*, grows only in the presence of sugar. This type of bacteria breaks sugar down to lactic acid, which combines with calcium in the teeth. When this chemical combination occurs in a

place where the saliva cannot reach the acid to neutralize it, a cavity results.

A group of investigators from the University of Michigan studied the teeth of children in an orphanage where the diet was far from adequate. Since the children received no sweets in any form, they were immune to tooth decay. Then candy was given them, and in two months active decay took place in almost every mouth. When the candy was withdrawn, the active decay was arrested and there was no further occurrence of it. After teeth are developed, they may be protected, regardless of how badly formed or poorly calcified, if no decay penetrates the enamel. For this reason, avoiding all refined sugar is probably the most important step in the prevention of decay. Even chewing gum contains enough sugar to cause decay.

Many body requirements contribute to the building and maintenance of sound teeth. Adequate vitamin A during the period of dental development is of particular importance in forming a normal, well-calcified enamel. Ample vitamin-B complex aids in the absorption of minerals and vitamins necessary for dental health. Adequate ascorbic acid prevents the dentin from losing minerals and keeps the bones and gum tissue healthy. Vitamin D is of particular importance because it aids in the absorption and retention of phosphorus and calcium and in the utilization of both minerals during the development of teeth and their maintenance throughout life. Generous supplies of calcium and phosphorus are absolutely essential, and a lack of either always results in decay. The average decay is probably caused by a combination of several subtle deficiencies. An adequate diet appears to be unable to prevent tooth decay unless refined sugar in all forms is avoided.

Suggestions for reducing diets. The person who reduces as soon as he gains his first unwanted pound rarely has trouble.

Needless weight gained in high school is often maintained throughout life.

A wisely chosen reducing diet can build health. There need be few variations from the basic daily dietary. An entire quart of skim milk daily is of great importance, because milk

Serve fruit desserts the year round.

is filling and changes to a solid in the stomach, thus preventing hunger pains. The cod-liver oil should be in the form of non-fattening capsules. Citrus fruits should be eaten whole, because solids are more filling than juices.

If only a few pounds are to be lost, wheat germ can supply the needed vitamin-B complex. If the reducing must be done more seriously, then powdered brewers' yeast stirred into water offers fewer calories with more vitamins.

Frequent meals are absolutely essential. Skim milk, tomato

juice, raw carrots or other vegetables, or small amounts of fresh fruits should be eaten at 10 A.M. and 3 P.M. Only lean meats should be used, and the cheaper varieties of cottage cheese. Eggs may be prepared in any way except fried. Fats in all forms should be avoided.

Perhaps the easiest of all ways to reduce is to become a raw-vegetable faddist. Raw vegetables digest less completely, have a harder texture, and stay in the stomach longer than cooked ones do. It is impossible to eat enough radishes, green onions, tomatoes, raw carrots, raw turnips, and lettuce to gain weight. The vegetables should be restricted to the 3, 5, and 10 per cent ones listed on page 33. Vegetable soups are filling and low in calories.

Since fruits contain much larger amounts of sugar than do vegetables, they should be largely avoided except when only a little weight need be lost.

Soft drinks of all kinds usually contribute about 100 or more calories per serving and should be avoided. If the person has an uncontrollable desire to go off his diet, he should eat carbohydrate foods rather than fats.

More than any other food, brewers' yeast helps to make reducing easier. Although it is low in calories, the large amount of protein yeast contains makes it extremely satisfying to the appetite. The quantity of B vitamins it supplies causes the person taking yeast to feel so well that he is more energetic than usual; hence he uses more calories and more readily reduces. The B vitamins also prevent the craving for sweets which quickly occurs when these vitamins are undersupplied. Although yeast is usually considered most palatable when mixed with grapefruit juice, fewer calories are obtained if it is mixed with water or tomato juice. It should be mixed with skim milk only when the person wishing to reduce finds it difficult to drink much liquid.

Yeast lumps easily and is difficult to mix unless a definite technic is followed. Put a pint of liquid, water, skim milk, or juice, into a quart jar and add 4 heaping tablespoonfuls of yeast; stir slightly and finish filling the jar with liquid. Let the mixture stand an hour or longer. The yeast will settle to the bottom of the jar, all lumps dissolved. Stir it well before pouring out each glassful. Keep it in the refrigerator. When the jar is empty, mix another supply.

Your reducing program might be as follows:

Breakfast: 1 heaping tablespoonful of yeast with 8 ounces of water, skim milk, or grapefruit or tomato juice
1 sliced orange or small serving melon or berries
1 egg; poached, boiled, or scrambled in skim milk
½ slice whole-wheat toast without butter
1 glass skim milk, if not taken with yeast
1 or 2 fish-liver-oil capsules

10 a.m. raw carrot, celery, or tomato or tomato juice

Lunch: 1 heaping tablespoonful of yeast with 8 ounces of water, skim milk, or grapefruit or tomato juice
cottage cheese or lean meat
large plate of raw vegetables
1 glass skim milk

4 p.m. 1 heaping tablespoonful of yeast with 8 ounces of water, skim milk, or grapefruit or tomato juice

Dinner: fat-free bouillon or vegetable soup, if desired
lean meat, fish, or fowl; broiled or roasted
1 cooked vegetable, 3 or 5 per cent carbohydrate
large salad of raw vegetables
1 teaspoon mayonnaise or French dressing
1 glass skim milk

At bedtime: 1 glass skim milk or tomato juice or raw carrot or celery

If you follow this program carefully, you need not suffer from hunger for a single moment, yet you would probably lose 12 pounds or more each month.

Suggestions for gaining. When adequate foods are available, underweight is usually caused by nervous and muscular tensions which allow energy to be wasted, and by poor appetite, inadequate digestion, and incomplete absorption. Since calcium and vitamin D help to relax tensions, these substances should be more than adequate. Since the B vitamins normalize appetite, digestion, and absorption, they must be particularly emphasized. When these three requirements, the B vitamins, calcium, and vitamin D, are amply supplied, the person usually gains to his ideal weight without further effort.

Wheat germ should be used in every way possible, as a breakfast cereal and in breads, hotcakes, waffles, and muffins. Wheat-germ cookies and candy (p. 68) could be eaten for desserts or midmeals. The "malt" prepared by adding yeast, blackstrap molasses, and powdered milk to fresh milk (p. 192) is excellent for gaining; almost no other food can supply such a concentration of B vitamins, calcium, iron, and protein. A quart or more of milk should be consumed daily in order that adequate calcium may be supplied. Part of it may be taken as a beverage or as the "malt" or other milk drinks and the remainder in cream soup, custard, junket, or pudding. Fish-liver oil in malt or capsules should be taken daily as a source of vitamin D. Only whole-grain breads and cereals should be used. Cheese should be eaten daily. Dried fruits, nuts, and peanut butter can all be used to advantage.

Usually when a person wishes to gain he increases his intake of butter, cream, mayonnaise, and other fats. This procedure defeats its own purpose. Fats so readily satisfy his appetite that he is unable to eat health building foods. Instead of gaining he often loses weight. Fats should not be increased. In cases where the appetite is poor, they should be largely avoided.

Aside from these simple suggestions, adherence to the daily dietary outlined on page 365 is usually sufficient to bring about any desired gain in weight.

Suggested dietary during infections. Since ascorbic acid and protein stimulate the production of antibodies which destroy bacteria, your first thought must be to obtain these substances. Milk drinks, custards, junkets, and cream soups, made with a half cup or more of powdered milk added to each pint of fresh milk, is the easiest way to get concentrated protein. Ascorbic acid should be increased to about 300 milligrams daily, or 3 glasses of citrus juice. Orange shakes (p. 302) are ideal to drink during an infection because they combine protein and ascorbic acid.

The vitamin-A intake should be increased during most infections to assure rapid recovery and to prevent reinfection.

Since the requirements of vitamin-B complex are increased during infections, particular attention must be given to fulfilling this need.

Do not go among people when you have a cold or any other contagious infection. It may seem of little importance to you, but may bring about the death of someone else. However, with this possibility in view, it is a foregone conclusion that you would not willingly be the cause of such a fatality.

Suggestions for the serious student. Eyestrain from long hours of study increases your need for vitamin A. The daily use of apricots, carrots, and other colored fruits and vegetables, and the consistent taking of some form of fish-liver oil should supply your needs in this respect. Since the vitamins of the B complex, particularly thiamin and niacin, appear to increase mental vigor and alertness, these should be kept adequate. Frequent meals likewise aid clear thinking.

The person who studies a great deal usually takes little exercise and for that reason eats less than a more active person; therefore, the total intake of vitamins and minerals is correspondingly less. Careful planning is needed if adequate amounts of all body requirements are to be supplied.

Other problems. A physician should be consulted about problems of a more serious nature. Many conditions not mentioned here, such as poor muscle tone, slight anemia, fatigue, and breaking of fingernails, would be overcome by adherence to the suggestions for the daily dietary, provided all body requirements are well absorbed into the blood.

The important fact to bear in mind is that no one body requirement can solve your problem, but that every need of the body must be met day after day, year in and year out, if you are to achieve ideal health.

Case History

Jack H. first consulted Dr. M. A. when he was twenty-five years old. He had suffered from the most severe type of acne ever since he was fourteen. His face, neck, shoulders, and chest were covered with deeply pock-marked scar-tissue. The inflamed skin, purple-red in color, indicated an accumulation of slow-moving blood. There were probably fifty small boils on his face, neck, back, and arms. His pulse was 42. He was not chilly, a fact which indicated that no pronounced iodine deficiency existed. Although he had consulted many physicians, and many dollars had been spent in an attempt to clear up his condition, the only suggested change in diet had been to omit sweets.

In addition to a basic diet similar to that given on page 365, Dr. M. A. asked Jack to take 3 heaping tablespoonfuls of powdered brewers' yeast daily, which was to be stirred into 6 ounces of either canned or fresh citrus juice and taken after each meal. One capsule of haliver oil, which contained 25,000 units of vitamin A, was also given after each meal. In this manner, vitamins A, C, and those of the B-complex were made unusually high.

In a month's time, Jack's pulse had increased to 64. His skin showed almost normal color, and only one small boil was evident. Continuation of the diet brought complete recovery.

Projects

1. Plan a diet for yourself adequate to meet your particular health problems. Remember that requirements which have been lack-

ing are needed in greater than normal amounts when correction is desired.

2. Make out a day's menus for a person who wishes to reduce but who has an excessive appetite.
3. Plan a week's menus for school lunches. Analyze these lunches for body requirements and compare with lunches chosen by students in the school cafeteria. Which type of lunch is superior?
4. Prepare the following sandwich spreads in the classroom so that each student may sample them. Mix together a half cup each of honey and peanut butter; when well blended, stir in 1½ cups of wheat germ. Spread on whole-wheat crackers or bread. Make a similar spread of a half cup each of blackstrap molasses and peanut butter, 1½ cups of wheat germ; add nuts or raisins as desired. Prepare these spreads at home and keep in a covered jar. Use for school lunches or afternoon midmeals instead of sandwiches of jam or jelly.

Topics for Discussion

1. Why can a single improvement in diet be expected to bring about little increase in health? Name several causes of tooth decay, anemia, and acne.
2. Name foods which you formerly disliked but which you now enjoy. How did you cultivate a taste for them?
3. How can the managers of your school cafeteria be influenced to serve more health-building foods? What improvements would you suggest?
4. Why are ascorbic acid, vitamin A, and the vitamins of the B complex, and iodine especially important in treating acne? Why should iodine and the vitamins of the B complex always be amply supplied the overweight person?
5. How many people in your classroom have teeth entirely free from decay? In what respect does the diet of the person who is immune to decay differ from that of the person who has active decay?

Chapter 37

PREPARING FOOD TO RETAIN MAXIMUM VALUE

The home-cooking methods used today are largely those which have been handed down from mother to daughter, through generation after generation, and date back to times when the science of nutrition was unknown. As a result, it is probably true that, in the majority of homes, out of every ten dollars spent on food, five-dollars' worth of actual nutritive value is either destroyed or thrown away before the food reaches the table. If health is to be built, scientific methods must be used in handling and preparing all food.

Effect of room temperature. Carotene and vitamin A, thiamin, and particularly ascorbic acid, are destroyed by combining with oxygen. This is a chemical combination which is accelerated by heat; hence many more vitamins are destroyed at room temperature than when the food is refrigerated. In the case of ascorbic acid, the chemical combination of oxygen and vitamin is known to be brought about by an enzyme, and there is little doubt but that enzymes hasten the destruction of other vitamins. Since enzymes are proteins, they are destroyed by boiling. Their action is inhibited by cold and dryness, although not destroyed by either. They are especially active when moist and when at room temperature. The saving of vitamins, therefore, resolves itself into the prevention of enzyme action and to the keeping of oxygen away from food. The skin of foods such as apples, oranges, potatoes, and root vegetables largely prevents contact with oxygen, and, for this

reason, the vitamins are not readily destroyed unless such foods are stored for a long time. On the other hand, leafy vegetables, kept at room temperature until wilted, which may be only one day, lose half of their ascorbic acid and much of their carotene and riboflavin content. Therefore, all fresh foods should be carefully covered to prevent contact with the air, and only that amount of fresh foods should be purchased at one time or brought in from the garden which can be stored in the refrigerator. Since riboflavin is destroyed by light, the darkness of a refrigerator also helps to preserve it.

When foods are taken from the refrigerator and allowed to heat to room temperature, the destruction of vitamins is rapidly resumed. For this reason, no food should be allowed to stand before cooking; and salads should be prepared immediately before serving, or, if they must be prepared in advance, they should be placed in the refrigerator.

Effect of soaking. Any nutritive substance which dissolves in water will quickly pass from food into water during soaking. All sugars, all minerals, ascorbic acid, and all of the vitamins of the B complex readily dissolve in water. You will remember that fruits and vegetables contain glucose, fructose, and sucrose. When these foods are soaked before and during cooking, so much of the sugars dissolve into the water that most of the flavor and sweetness is lost. Anyone who has tasted turnips, parsnips, carrots, and almost any vegetable fried or cooked without water is amazed to find how sweet they are.

Foods should be washed as quickly, but as thoroughly, as possible. With the exception of dried foods, under no circumstances should they ever be soaked. It is far better for apples and potatoes, for example, to become slightly discolored during peeling than to keep them in water. If foods are peeled before cooking time, they should be wrapped in oil-silk bags or wax paper and kept dry in the refrigerator. If salad vegetables

need to be crisped, sprinkle them with water but do not soak them.

Beware of recipes which recommend soaking. For example, a particular recipe for preparing kidneys advises that they be soaked in salt water for an hour; that this water be discarded and replaced by fresh water, also to be poured off; that they be parboiled for a half hour, and the water thrown away, all before the actual cooking begins. The person who originated such a recipe was, of course, profoundly ignorant of food values. How many minerals and B vitamins in kidneys could survive such treatment? Actually, kidneys should be washed, and then the connective tissue in the center (which has a strong flavor) should be clipped away with the kitchen scissors. That is all the preparation needed before cooking them. Another notoriously bad recipe advises the soaking out and throwing away of the vitamins and minerals in liver, the richest known source of the B complex. These and similar recipes do incalculable harm to the health of the nation.

The amount of water used in soaking such foods as dried fruits and legumes should be only that which the food itself will absorb plus a small amount for cooking. This amount is usually about three fourths of the volume of the food itself.

The quantity of vitamins, minerals, and sugars lost by soaking depends on the length of time the foods are soaked and the amount of food-surface exposed to the water.

Effect of peeling, slicing, grating, chopping, and crushing. Peeling, slicing, grating, chopping, and crushing often bring about extremely serious losses of food value because these processes tremendously increase the surfaces of the food exposed to air or water. For example, the surface area of a whole carrot, 5 inches long and 1 inch in diameter at the top, is about ten square inches. If this carrot is sliced into 25 slices, the exposed surface area becomes about 60 square inches. If a carrot of the

same size were chopped or grated, the exposed surface area is increased thousands of times. The greater the surface area exposed to air, the more readily oxygen can combine with and destroy the vitamins, and perhaps a hundred or a thousand times more destruction will result than would have taken place had the food been left whole. If the food is soaked in water, the more surface area exposed, the greater the amount of minerals, sugars, and vitamins which can soak out into the water, or the greater the loss of both food value and flavor. On the other hand, foods which are sliced, chopped, grated, or crushed cook more quickly than those which are left whole. As we shall see shortly, quick cooking is advantageous. Therefore we must weigh the advantage against the disadvantage.

Any treatment which increases the surface area is advisable only under two conditions: first, that the food be so chilled that enzyme and chemical action cannot take place and hence the vitamins cannot be destroyed; second, that such food never be soaked unless the liquid is to be completely consumed. For example, if chilled carrots are quickly grated, and immediately cooked or served in salad, or if potatoes to be fried are washed, chilled, quickly sliced, and put into the frying pan, little loss occurs. Since the saving of ascorbic acid depends upon speed, every housewife should have sharp equipment for slicing, chopping, and grating.

Aside from exposing surfaces to air or water, peeling should be avoided because too much of the food is wasted. Many minerals, particularly in root vegetables, are concentrated in or directly under the skin; and flavors are lost. For example, any person who has eaten unpeeled pears, baked, steamed, or canned, will testify that their flavor is more delicious than similarly prepared peeled fruit.

Effect of cooking. The losses during cooking are largely due to three causes: continued enzyme action until the enzymes

are destroyed by heat; actual destruction of vitamins by heat; and the passing of nutrients into the cooking water.

To destroy enzymes quickly, heat all foods as rapidly as possible. Have the oven hot before putting foods in; preheat steamer or, if waterless cooking is to be done, the casserole; if frying or cooking in water, have the fat hot or the water boiling; in all cases, turn the fire high until actual cooking begins and then lower it. Your method of heating will determine whether ascorbic acid is retained or destroyed. For example, if cabbage is put into boiling water which is again quickly brought to a boil, only 25 per cent of the ascorbic acid is destroyed compared to 75 per cent when started in cold or lukewarm water and slowly heated. The accumulative loss of ascorbic acid, needlessly destroyed by poor cooking methods, can mean the difference between health and sickness. For instance, in England during the second World War, scurvy was reported in communities where cabbage, one of the richest known sources of ascorbic acid, was a principal food.

The destruction of vitamins by heat is in proportion to the length of time the food is heated. Carotene and vitamin A are harmed by heat, only in the presence of oxygen. For this reason, foods should not be stirred during cooking nor puréed while hot; steaming is superior to other methods of cooking because air is replaced by steam; butter should not be used for frying and that used for seasoning should be added only when the food is served. Ascorbic acid is harmed by heat only in the presence of an alkali, as when soda is added to cooking vegetables, or when food comes in contact with copper which causes an immediate and complete destruction of the vitamin. Conversely, this vitamin is protected by acid which accounts for the fact that tomato and citrus juices lose little ascorbic acid during canning. Thiamin is destroyed by heat in proportion to the temperature, but it is completely destroyed only when

heated under pressure for a number of hours. When foods are fried at a high temperature or cooked under pressure, the food is cooked so quickly that the actual destruction of thiamin is less than if it were cooked slowly at a low temperature. Riboflavin is quickly destroyed during cooking if the food is not kept covered or is prepared in a glass utensil. If all foods are cooked by the quickest possible method in covered, metal utensils, little food value is lost because of heat.

By far the greatest loss occurs by cooking foods in water and discarding the liquid. The extent of this loss can be shown by the fact that from 20 to 40 per cent of the thiamin and about 35 per cent of the ascorbic acid in peas pass into the water by the time they are boiled five minutes, yet these are only two out of twenty or more nutrients which leave the food. Furthermore, most foods are cooked longer than five minutes, and the extent of the loss is also in proportion to the length of cooking time. Yet, in the majority of homes, foods are boiled and the water discarded.

It is obvious that the best method of cooking is not only one which cooks food in the shortest time possible, but also one which demands the least water. Although each method has both advantages and disadvantages and some losses are unavoidable, different methods probably rank in the following order: steaming under pressure; steaming without pressure; waterless cooking; frying; baking; boiling. There is no objection to boiling provided the food is rapidly heated and all cooking liquid is used. Many people feel that if only a little cooking water is left, it is not worth saving; actually, the less liquid, the more concentrated the nutrients in it, and the more valuable. Others believe that if all water is evaporated off, the vitamins, minerals, and sugars mysteriously scramble back into the food; obviously, they are only dried on the bottom of the pan and are lost.

Effect of overcooking. Overcooking is a habit so destructive to health that it can scarcely be exaggerated. The longer heating causes a larger amount of water-soluble nutrients to pass into the cooking fluid and a far greater destruction of vitamins harmed by heat. The breaking up of overcooked food increases the surface area just as does chopping, and the escape of nutrients is still further accelerated. This loss is increased still more by the fact that cell walls of the food break down, freeing the entire contents into the cooking liquid. The loss in nutrients is thereby so great that the money spent on the food may be considered largely wasted, and the flavor is so destroyed that it is difficult to pass a blindfold test to distinguish one food from another. The loss of flavor caused by the abominable habits of soaking before and during cooking and of overcooking have caused millions of people to dislike vegetables, and, therefore, to accept a far lower degree of health than they could have attained.

Effect of salting. The time of salting can affect both taste and food value retained. If foods are put to boil in unsalted water, the water passes into the food so that it becomes waterlogged. If foods cooked without water are salted at the beginning of cooking, the juices are drawn out, causing a loss of both flavor and food value. Therefore when a food is to be boiled, salt the water before adding the food; if to be cooked without water, salt just before serving.

Effect of soda. Soda causes rapid destruction of ascorbic acid and may harm several vitamins of the B complex; therefore, soda should never be added to vegetables during cooking and it should be avoided in baking whenever possible, particularly if wheat germ and black molasses are used. In most recipes, soda can be either entirely replaced by baking powder or decreased to half the amount called for. Delicious hot cakes, waffles, muffins, doughnuts, breads, rolls, cookies, and

even cakes can be made by replacing the baking powder or soda called for in the recipe by a cake of fresh bakers' yeast. Since yeast is a plant which produces enzymes capable of breaking down sugar to carbon dioxide and water, it must be treated as a plant and given warmth, food, and time to grow.

Application of cooking methods to home canning. The diet of many families is adequate or inadequate during the winter, depending upon the amount of fruits and vegetables canned. Often canned foods are almost their only source of ascorbic acid. It is of extreme importance, therefore, that foods be canned in such a way as to retain their maximum food value.

All rules of handling, preparing, and cooking foods should be applied to canning. If dicing or chopping is necessary, foods should first be chilled. Soaking should be avoided. When foods are to be stewed and packed in sterilized jars (the open-kettle method) they should be cooked as quickly as possible. If raw fruits are packed into jars, covered with water or syrup and steamed (the cold-pack method), the liquid added should be boiling hot. Leafy vegetables such as spinach, kale, collards, chard, and beet and turnip tops should be steamed rapidly in their own juices, packed solidly into jars, and sterilized. When vegetables for canning are parboiled to stop enzyme action and to cause shrinkage, the same boiling water should be poured into the jars. Again, the quickest cooking method is desirable, which means that steaming with pressure is preferable to steaming without pressure, the hot-water bath, and, especially to the slow oven processing. Complete directions for canning are to be obtained from the United States Department of Agriculture.

Rules which save food value. The rules for retaining the maximum amount of nutritive value may be summarized as follows:

Purchase or bring from the garden only the amount of fresh food which can be kept in the refrigerator.

Wash all foods quickly.

Avoid peeling whenever possible.

Slice, chop, grate, shred, crush, or peel foods only when thoroughly chilled. Prepare just before serving or cooking.

If foods must be prepared in advance, cover from air and light and store dry in the refrigerator.

To freshen salad vegetables, sprinkle lightly with water but do not soak. Keep in covered refrigerator pan.

Soak no food unless dried, then use only the amount of water which can be absorbed.

Reheat canned foods in the liquid in which they are canned.

Do not stir air into foods while cooking or pass them through a sieve or puréer while hot.

Never add soda to vegetables.

In baking, yeast is preferable to either baking powder or soda: baking powder is preferable to soda.

If foods are to be boiled, put them into water which is already boiling and raise to boiling temperature as quickly as possible.

Use the shortest cooking method and heat foods rapidly.

If cooking in boiling water, salt first; if cooking without water, salt just before serving.

Start cooking frozen foods before they have thawed.

Serve frozen fruits immediately after thawing, if they are to be served without cooking.

Modernize all recipes before using them.

Keep foods covered during cooking; avoid glass utensils.

Do not throw away liquid in which foods have been cooked: keep in covered jar in refrigerator and use for gravies, sauces, soups, or for drinking water.

Food preparation and palatability. The intelligent person has two standards for the foods he chooses: first, they must build health; second, they must taste delicious. Scientific methods of handling, preparing, and cooking foods bring out and preserve their natural flavors.

An experiment was carried on by Dr. Okey at the University of California in a school where children refused to eat vegetables. When the same kinds of vegetables were scientifically prepared, the children not only demanded second and third servings, but their height, weight, and general health showed marked improvement. In the same way, your health and the health of your family are in direct proportion to the soundness of the methods of preparing foods in your home.

Projects

1. If facilities are available, have a class demonstration of any cooking method not familiar to students, such as steaming with pressure, without pressure, and waterless cooking. For your demonstration choose some food which is frequently overcooked, such as string beans or mustard greens.
2. Obtain fresh bakers' yeast, mix a little with each of the following: lukewarm water; ice water; boiling water. Inspect under the microscope.
3. Calculate the quantity of ascorbic acid probably lost in one year if the amount of vegetables served daily contained an average of 400 milligrams, and if all vegetables were started to cook in cold water and all cooking liquid were discarded. How much would this cost, in terms of ascorbic acid if purchased in restaurants in the form of orange juice at $0.10 for an eight-ounce glass?
4. Calculate the amount saved in one year if a quart of cooking liquid which has the following average content, accumulates daily and all is used in soups, gravies, sauces, or for drinking: thiamin, 2.87 mgm.; riboflavin, 2.58 mgm.; niacin, 3.2 mgm.; ascorbic acid, 15.3 mgm.; calcium, 80 mgm.; iron, 3 mgm.; glucose, 11 grams; fructose, 9.6 grams; sucrose, 8.9 grams.
5. Look through recipe books and choose five recipes which do not observe the rules of retaining food values. How would you modernize them?

Topics for Discussion

1. Name at least twenty nutrients which will likely be in the cooking liquid, if vegetables are boiled in water and overcooked. Sug-

gest ways of using cooking liquid. What nutrients are not harmed regardless of cooking time?

2. Give reasons for each of the rules for retaining food values.
3. Name as many methods of cooking as you can and discuss the advantages and disadvantages of each. Why do some methods cause a greater loss of flavor than others?
4. If soda or baking powder in a recipe is replaced by yeast, why should the dough be prepared 2 to 3 hours before time for baking? Why should lukewarm liquid be added to yeast rather than boiling water? What would occur if a yeast dough is placed in the refrigerator? If you were baking yeast cookies, would you have the oven temperature high or low? If, an hour before time to eat, you decide you want yeast waffles for breakfast, how could you prepare them quickly?
5. Discuss different methods of canning and point out what rules of retaining food value should be applied to each.
6. In what ways are nutrients unnecessarily destroyed or lost in your home?
7. Which would contain the larger amount of thiamin: the crust of bread or the inside of the loaf? Toasted or untoasted bread? Wheat germ cooked five minutes or half an hour? A roast cooked under pressure for 20 minutes or baked slowly for two hours?

Chapter 38

BUYING HEALTH ON A LIMITED BUDGET

A basic diet which includes, for example, a quart of milk daily for every person will naturally be more expensive than a diet which recommends only a pint daily. Does the fact that many people cannot afford this amount of milk justify lowering the health standards?

Dr. McCollum of Johns Hopkins University, one of the foremost authorities in nutrition, long ago set one quart of milk daily as a standard from birth until death. This amount of milk is needed daily by children to supply the quantity of calcium required for normal development, and by adults to furnish riboflavin. Certainly both calcium and riboflavin may be obtained from other sources, but they usually are not. The result is that people who do not drink milk are almost invariably deficient in these requirements. To people of all ages, whole milk contributes vitamin A, and any milk supplies protein of superior quality as well as many vitamins and minerals needed for health.

Many authorities, however, recommend only a pint of milk daily for adults. Such authorities have usually worked with people in the lower economic levels, many of whom drink no milk; hence it is impractical that a quart daily be recommended. Let us suppose that a person, who formerly has used no milk, learns of its value, or gets a cow, a new job, or an increase in salary. If he has been told that a pint of milk is sufficient, he will make no attempt to obtain a quart even when he can afford to do so. Millions of farmers throw milk to the

pigs when they and their families actually suffer from deficiencies of calcium, protein, and riboflavin, simply because of the lack of nutritional instruction and of low health standards.

If standards are kept high, those who can afford to buy the particular foods recommended on the basic diet can achieve a high degree of health; if they are lowered to the level which the person with the least income can afford, no one would achieve full health. The person with the limited income, if he attempts to reach the ideal, can obtain the same requirements from cheaper foods, and even surpass the low standards. High standards, therefore, are advantageous even though in some cases they appear to be impractical.

Health related to knowledge rather than income. Studies made by the United States Department of Agriculture have shown that the more money spent on foods, the more adequate the diet is likely to be without planning. On the other hand, the same survey showed—and this is important—that a great many people who could afford to buy any food they chose were living on markedly inadequate diets. Having enough money to eat as you like, therefore, by no means insures that an adequate diet will be chosen. Other studies have shown that, with nutrition instruction, from ten to twenty times more nutritional value is bought with the same money than was purchased without instruction.

Even though a person may not have enough money to buy the particular foods suggested on the basic dietary, other foods offering the same requirements may be substituted so that the diet is adequate, provided he knows what these foods are. The trained person on a limited budget can obtain a diet far superior to that obtained by an untrained person with an unlimited budget.

Substitutions necessitated by limited income. Substitutions are often difficult and imply the development of new tastes, but

they are by no means impossible. For example, if citrus fruits are too expensive, ascorbic acid must be obtained from tomatoes and fresh fruits and vegetables. If the budget is so limited that fresh fruits are unobtainable, raw cabbage and raw carrots should be eaten daily. In the absence of all other sources of ascorbic acid, potatoes should be eaten raw.

There are few families who cannot afford powdered skim milk even though fresh milk is beyond their means. If even powdered skim milk cannot be purchased, calcium is to be obtained from collards, kale, mustard greens, and turnip and beet tops (which are the calcium sources of the poor Negroes of the South); from the small bones of fish and chicken; and from such dishes as pickled pigs' feet, spare ribs, and other pickled meats where bones are soaked in vinegar to dissolve out large amounts of calcium. If no other source of calcium is available, an egg can be soaked either in any sour fruit juice or in diluted vinegar (which will dissolve much calcium from the shell) and the juice drunk. A careful study of the table of food analysis will show that each body requirement may be supplied at a cost to fit every pocketbook.

Dietary improvements without increased cost. Hundreds of small improvements in buying, meal planning, and preparation of foods lead to tremendous increases in supplying body requirements without any increase in cost. For example, if a medium sized potato, weighing 100 grams, is peeled in the usual manner and the peeling thrown away, about 20 per cent of the potato is lost. The average consumption of potatoes per person per year in the United States is 157 pounds. If all the potatoes were peeled, as they often are, a family of four would throw into the garbage 105 pounds of potatoes in one year. This amount would contain more than 500 milligrams of iron, 47,000 calories, and at least 9520 milligrams of ascorbic acid.

which, in terms of orange juice, would cost a great deal of money.

Obviously, any family on a limited budget should learn to enjoy the taste of foods unpeeled. The peeling on baked potato is delicious. Potatoes for mashing should be steamed in their skins, then run through a ricer or puréer. Potatoes for frying, creaming, or casserole can be sliced or diced with the skins on.

She has no pep for play or for work.
Iodine could make her thyroid perk.

If one were to compute the amount of waste occurring in one year when carrots, parsnips, turnips, apples, pears, and other vegetables and fruits are peeled, the losses of nutritive value would be astounding.

To take another example: few foods offer greater nutritive value than beet and turnip tops which the average family throws away. If either beet or turnip roots were eaten only once a week throughout the year by a family of four and all the tops thrown away, the amount of vitamin A alone which would be lost would be about 6,240,000 units. The quantities of riboflavin, iron, copper, vitamins E and K, and other nutrients lost would also be tremendous.

Aside from actual loss, many products of high nutritive value

cost the same or less than those of low value. Iodized salt sells at the same price as salt which contains no iodine. Whole-grain breads and cereals are no more expensive than the refined products. Pound for pound, blackstrap molasses, if bought in quantity, is much cheaper than refined sugar. Wheat germ, if purchased directly from a flour mill, is usually the least expensive cereal which can be obtained. Vitamin-D evaporated milk, and often fresh vitamin-D milks, sell at the same price as milks containing no vitamin D. Vitamin-rich yellow and green vegetables cost no more than the white varieties. Other examples of improving the diet without increase of cost are too numerous to mention.

Budgeting for health. Authorities suggest that if health is to be built, the money spent on food should be divided approximately in fifths. For example, if ten dollars is the food budget for one week, about two dollars should go for each of the following:

a fifth or more for milk, cheese, and butter or margarine
a fifth or less for meats, fish, and eggs
a fifth or more for bread, cereals, and grain products
a fifth for fruits and vegetables
a fifth or less for miscellaneous items.

The untrained housewife makes little attempt to buy health. Taste and price are largely her guides. She frequently purchases refined foods which appear to her to be inexpensive, but they are actually so costly for value purchased that even the wealthiest person could scarcely afford them. When loss in efficiency is considered and medical and dental bills are taken into account, this appearing economy is extravagant indeed. Let us now discuss each of these five classifications in detail.

A fifth for milk, cheese, and butter or margarine. The untrained housewife usually spends far less than one fifth of her

food money on dairy products. If the budget is limited, and yet health is to be bought, even more than one fifth must go for these foods.

In some localities, money may be saved by purchasing either fresh milk or buttermilk by the gallon. Buttermilk is usually cheaper than whole milk, but has only half the butterfat. As a substitute for cream, irradiated canned milks are much cheaper and nutritionally superior. They are often cheaper than fresh milk, and diluted with equal parts of water, they make a beverage which one can quickly learn to enjoy.

If the income is too limited to include ample fresh milk, powdered skim milk should be used as a substitute for all members of the family. (See pages 299–300.) A half cup of powdered skim milk is equal to slightly more than a quart of fresh skim milk. Mixed in the proportion of a half cup of powder to a quart of water, it may be used for drinking or in making any food prepared with milk, such as cream sauces or soups. It may be added to the flour in baking; in this case, the water in which bland (not too highly flavored) vegetables have been cooked should be used instead of the liquid called for in the recipe.

If powdered skim milk is the sole source of milk, somewhat more butter or margarine to which vitamins A and D have been added should be used to replace the calories and vitamins in the butterfat ordinarily obtained from whole milk. Such margarines are cheaper than butter, and the vitamin content is often higher, especially during the winter when cows are on dry food.

The cheaper varieties of cheeses sometimes contain less butterfat than expensive cheeses, hence less vitamin A and calories, but usually the higher price is asked because of taste rather than nutritive value. All cheeses, regardless of price, are excellent sources of calcium, riboflavin, and complete protein, and they

should be used frequently. The coloring in cheese is artificial and does not indicate vitamin-A content.

A fifth or less for meats, fish, and eggs. The untrained housewife usually spends more than twice as much for meats as their health-building qualities justify. Actually, the more limited the budget, the less money should be spent on meats.

Steaks, chops, and roasts are usually the most expensive items on the food budget. Liver, kidney, brain, spleen, heart, and pancreas are nutritionally superior to other meats. With the exception of liver and pancreas (sweetbreads), they are cheaper than other meats. Pork and mutton liver are inexpensive and may be fried, broiled, baked, steamed with onions, parsley, garlic, and carrots. After cooking, they may be sliced and eaten either cold or hot or put through a food chopper and ground to a sandwich paste. Kidneys may be broiled, fried, or used for stew and kidney pie. Heart is delicious stuffed with sage or vegetable dressing. Spleen and brain may be prepared with scrambled eggs or cubed, browned with onions, and served in Spanish sauce. All of these meats are delicious added to meat loaves. If liver or brain is used, they should first be steamed in a little milk, then passed through a food chopper, and the milk added to the loaf.

The cheaper cuts of meat are as nutritious as the expensive ones provided large amounts of fat and connective tissue are not purchased. Meats are so universally enjoyed that, when the budget is limited, it is important not only to buy cheaper cuts but to prepare dishes which contain enough meat to give the desired flavor and yet keep the price from being high. Such dishes are especially valuable if the meat is combined with another food rich in protein. The following suggestions are made:

meat, fish, or fowl prepared with whole-grain noodles
meat with beans, as in chili con carne, pork and beans

bacon with soybeans, or sausage with beans
meat with brown rice as in Spanish rice
meat and rice patties
meat stuffed into peppers
meat rolled in "wilted" cabbage leaves and cooked in tomato sauce
meat balls with whole-grain spaghetti or macaroni
meat loaves to which is added soybean flour and chopped or grated vegetables, such as carrots, celery, parsley, peppers, turnips, parsnips, or potatoes
ham hocks or sausage with whole or split peas

The ingenious cook can originate many other such dishes to save money and also contribute more nutritive value than meat alone.

Fish is often cheaper than meats and, when available, should be used frequently. Like meats, the cheaper types of fish are as valuable to health as expensive ones. Mussels and many little-used shellfish are excellent sources of iodine and protein and are often purchased very cheaply.

Eggs should be used as generously as the budget allows. If space for storage is available, eggs should be purchased when least expensive and put into a preservative for use when prices are high.

A fifth or more for breads, cereals, and grain products. The more limited the income, the larger the quantity of grain products eaten. If only the whole-grain products and the more nutritious varieties are chosen, this increased consumption is an advantage, as it causes the diet to be superior in the B vitamins, iron, and many minerals to that of most well-to-do people. Rather than the white varieties, brown rice and yellow hominy should be used. These foods, as well as whole buckwheat and whole-grain noodles, macaroni, and spaghetti, make excellent inexpensive meat substitutes. Aside from wheat germ, which should be used daily, all breads and cereals purchased should show the mark of 100 per cent whole grain

on the label. Costs can be cut and nutritive value gained by making at home whole-wheat yeast bread which contains generous amounts of wheat germ, powdered milk, and blackstrap molasses. Such breads are heavy, but one can easily learn to prefer heavy breads to light ones.

A fifth for fruits and vegetables. The untrained housewife on a limited budget spends far less than one fifth of her food money on fruits and vegetables. Lack of these foods causes great detriment to health in terms of too little vitamin A, ascorbic acid, and minerals. The first rule for purchasing fresh foods is to buy in season. When the price is at its lowest, large quantities should be purchased to can for use throughout the year. Anyone who plants a garden or orchard should plan excess fruits and vegetables for canning. People who live in cities can obtain foods for canning at large wholesale markets.

The dried legumes, peas, navy, lima, and kidney beans, lentils, and particularly soybeans all make excellent meat substitutes. Dry soybeans contain almost two and a half times more protein than do most meats. Since proteins become tough when cooked at high temperature, soybeans should be soaked over night, using equal parts of water and beans, and simmered in the same water until tender. The cooking time is greatly shortened if they are frozen after being soaked.

As we have learned, more food value can be purchased for the same amount of money if green and yellow fruits and vegetables rather than colorless ones are chosen; if green vegetables rather than the bleached varieties are used; and if sulfur-dried fruits are obtained rather than sundried ones.

A fifth or less for miscellaneous items. The greatest mistake of the untrained person comes in purchasing miscellaneous items such as sweets, pastries, soft drinks, candies, pickles, coffee, tea, and refined sugar and syrups. The amount of money wasted on items which can in no way build health is

appalling, and this amount is often proportionately larger the more limited the income. Such purchases should be cut to the absolute minimum. Before any money is spent, the shopper should ask, "Can this food build health?" If it cannot, the money had best be spent for some other food.

This fifth of the food money should purchase iodized salt, fish-liver oil, blackstrap molasses, cooking fats and vegetable oils, and all healthful foods not mentioned in the other classifications.

Inexcusable extravagance. Buying health means not only wise spending of the food money, but also economical use of the food itself. The American housewife has no conception of the actual food value which she throws into the garbage pail and which could be used to advantage. The water from cooking vegetables should be used with powdered milk in making breads, or for making sauces, gravies, soups, and drinking, especially if the budget is limited. Much such water may be reheated and used for cooking a second time, hence the nutrients become more concentrated. Regardless of how long such water is heated, all of the vitamins of the B groups except thiamin and folic acid, all minerals and sugars are unharmed.

The hard or dry stalks of celery and asparagus, and tender pea pods should be cooked, puréed, and used in making cream soups. Carrot, radish, and celery tops (turnip and beet tops if these are not eaten), outer or wilted leaves of lettuce, cabbage, and spinach, the peelings of carrots, turnips, and other vegetables (if they must be peeled), the hard or dried stocks of broccoli, cabbage, and pea pods should be kept for making soup stock, in a special oilsilk bag in the refrigerator. Such vegetables may be stewed, with or without a soup bone, in vegetable cooking water. The economy of such a practice is great and results in varying and delicious stock to which onions, tomatoes, and other vegetables may be added after

straining. Excellent soups can be made with such stock, vegetables, margarine or butter, and perhaps whole-grain noodles, without the use of any meat whatsoever.

Buying in quantity. When a food keeps well and storage space is available, foods should be bought in quantity. If storage space is not available, a group of friends can save money by buying together in quantity. When large quantities are to be purchased, the cheapest price is usually obtained directly from the source of supply. For example, grains and wheat germ can be obtained directly from the flour mills; blackstrap molasses from the molasses companies; powdered milk from the large dairies; yeast from yeast companies or breweries.

Not a matter of dollars and cents. Gardening and canning, both vitally important for health, are hard work. The cultivating of new food tastes demands a certain strength of character. To search out the cheapest markets is often time-consuming and it requires effort. To change habits of buying, food preparation, and eating is usually not easy. By such efforts, however, a diet can be made adequate even though an extremely small amount of money is spent.

An adequate diet is not a matter of dollars and cents, but of intelligence and planning, and often of pluck and hard work, prompted by a conviction that full health is worth striving for.

Case History

Mr. T. was "on the county" (on relief). He and Mrs. T. received forty-eight dollars a month with which to buy food for themselves and their four children who ranged in age from eight to thirteen years. The entire family was always ill. The children were pale, hollow chested, round shouldered. Colds and tooth decay were a matter of constant occurrence. Through a course in nutrition given under the adult education program, the father and mother became extremely interested in nutrition.

Mr. T. purchased wheat germ directly from a flour mill in sixty-pound sacks; it was used daily as a cereal and Mrs. T. made bread of half wheat germ to which blackstrap molasses and powdered skim milk were added. Powdered skim milk was used for drinking (often with black molasses stirred into it), and for making sauces, puddings, soups and custards. Margarine to which vitamins were added took the place of butter, and canned milk was used for cream. Large sacks of dried beans, peas, and soybeans were purchased and used frequently. Meats were confined to the cheaper glandular cuts and fish, which Mr. T. bought at the waterfront. The owner of a vacant lot next door allowed them to plant a garden, and it was planned to produce vitamins and minerals the year around. The children collected mayonnaise, peanut-butter and coffee jars from the neighbors and from the city dump, and these were used for canning. Mr. T. was given, for the picking, tomatoes too small to be sold, and a winters' supply of ascorbic acid was bottled. He bought salmon-liver oil for vitamin D, and blackstrap molasses and many grains at poultry- and stock-feed stores.

In a very short time color came into the family's cheeks, the hollow chests filled out, and the shoulders straightened up. The children's grades improved and there were fewer visits to the dentist.

The teacher of the nutrition course asked Mr. T. one day how the children enjoyed the diet. Mr. T. looked surprised and even a little hurt. "Like it?" he said abruptly. "It's not a question of their liking it. Health is more important than taste, isn't it?"

Projects

1. Obtain a gram scale and weigh both before and after peeling: white potatoes, sweet potatoes, carrots, parsnips, turnips, apples, pears. Calculate the percentage of loss if the peeling is thrown away.
2. Find out where the following may be purchased by people in your community and then obtain the relative prices depending on the amount and place from which bought: powdered milk, blackstrap molasses, wheat germ, whole-wheat macaroni, noodles, and spaghetti, and any other healthful food not sold in all groceries.

3. Compare the price of 100 milligrams of iron purchased in the form of white bread and whole-wheat bread, on the basis of $0.10 for a pound loaf of either, and 16 slices per loaf.
4. Compare the cost of protein obtained from 1 pound of soybeans with the cost of protein from 1 pound of steak.
5. Keep an account of all money spent on foods in your home for one week. Divide the total expenditure into fifths and the foods into the five suggested groups. Is your family spending either too much or too little for any group of foods? What improvements would you suggest?
6. Keep an itemized account for one week of all foodstuffs purchased which cannot build health. Is this expenditure justified?
7. Compute the price of thiamin purchased in 5 pounds of wheat germ and compare the cost to the same amount obtained from white bread.

Topics for Discussion

1. Which meat substitutes offer more nutritional value than muscle meats? Why?
2. How much shark- or halibut-liver oil with viosterol would need to be added to a quart of vegetable oil to give the vitamin potency of cod-liver oil? What vegetable oil would be cheapest to use? How could the fortified oil be used in foods without loss of vitamins?
3. If the person with little money to spend chooses his diet wisely, in what respects will it likely be superior to that chosen by a well-to-do but untrained person? In what respects, the same? In what respects, inferior?
4. Name the cheapest sources of each body requirement. Analyze the basic diet according to body requirements supplied by each food, and suggest inexpensive substitutes for each.
5. Why are foods like refined sugar, and white breads and cereals actually extremely expensive?

Chapter 39

FOOD FOR THE SICK

An entirely adequate diet is one of the most important factors in maintaining health. Even though a person may have an entirely adequate diet, however, lack of sleep, overwork, sudden temperature changes, exhaustion, or constant worry may undermine his resistance and lay the seedbed for illness. If, under these conditions, he is attacked by bacteria in sufficient numbers, he will very likely become sick. In this event, his defense mechanisms will have been overwhelmed, and consequently his body must put up a fight. Therefore, his food intake during illness must be as adequate as it can possibly be made.

In the majority of cases, a poorly chosen and inadequate diet, together with such factors as worry, overwork, chill, and lack of sleep, usually combine to cause the body's resistance to be lowered. If this occurs, it is of still greater importance that the diet during illness be planned to meet all of the body requirements. As we have seen, many of these requirements, particularly of vitamins A, the B complex, and ascorbic acid are increased during illness.

Following the physician's advice. If the condition is serious enough so that a physician has been called in, he will undoubtedly give advice concerning the diet, and his directions should be followed implicitly. If the diet does not play a prominent part in the treatment, however, the physician may give only general advice or specify that he wishes the patient to be kept on a *liquid*, a *soft*, or a *light* diet. Unless some member of the family has been trained to know the foods which are included

The invalid must be given frequent feedings of nutritious foods: cookies made of wheat germ, finely ground whole-wheat flour, and powdered milk; and orange shake made by shaking together 1 cup of fresh orange juice, ¼ cup of powdered whole or skim milk, 1 teaspoonful of sugar, and a drop of vanilla.

in these diets and has some knowledge of what makes for adequate nutrition, it would be difficult to follow the physician's advice.

In many minor disturbances where no physician is called, there is often need for a modification of the ordinary family diet. It is important, therefore, to understand the principals upon which diets for the sick are built.

Calorie requirements and efficient energy production. The energy requirements during illness are identical with those for the same activities during health, or about 1500 to 1800 calories daily for an adult who is resting in bed. When the patient has

fat stored on his body, which can be used as the chief source of calories, no great effort need be made to meet the full calorie requirements, especially if the illness is likely to be a short one. During long illnesses, particularly if there is a fever which burns fat rapidly, calories must be generously supplied.

If the illness is acute and little food may be taken, the first thought should be to supply carbohydrates to yield the glucose necessary to burn the stored fat efficiently. The breath of the patient should be smelled frequently to see if acetone is being given off. The presence or absence of this characteristic odor serves as a guide as to whether or not the carbohydrate requirements are being met. When acetone is present, carbohydrate feedings should be given every hour until the odor disappears. During severe illness, particularly when accompanied by nausea or vomiting, a few tablespoonfuls of sweetened orange juice or black molasses stirred into milk, is all that can be tolerated. If vomiting is so severe that no liquids can be taken, physicians have frequently recommended that the patient suck lemon drops. In cases where no carbohydrate food can be eaten or retained, the physician is forced to inject glucose solution directly into the blood.

Fundamental considerations. It is generally assumed that, during illnesses, the weakness and sluggishness of the body reflects itself in the digestive tract. The diet for the sick is, therefore, built on the three following assumptions:

1. That less digestive juices are secreted by the stomach, intestine, and pancreas, and that the flow of bile is decreased.

2. That fewer digestive enzymes are produced.

3. That muscular contractions throughout the digestive tract are decreased, which result in: foods being less well mixed with digestive juices and enzymes; already digested foods not being brought into contact with the absorbing surfaces of the intestinal wall; faulty elimination of waste materials.

During illness, therefore, foods which under normal conditions would be completely digested and absorbed, may be digested very incompletely and, even if digested, may be poorly absorbed into the blood.

Principles of a diet for the sick. The diet for the sick should be prepared in such a manner that food may be as completely digested as possible. The general principles of such a diet may be listed under four headings:

1. Foods are chosen which require little digestion or which are partly predigested, such as milk in the form of junket; toast in which the starch is already partially changed to dextrin, and fruit juices containing glucose and fructose which can pass directly into the blood without being broken down by enzymes.
2. As the patient may feel too ill to chew his food thoroughly, foods are allowed which are in such small particles that enzymes can surround them and thus digest them more completely than large pieces. Liquids are given first place because much of the food they contain is already dissolved and is therefore in small particles. Any solid food which does not readily break into small pieces (as dry toast) or melt (as oils and some fats) should be puréed or mashed.
3. Only small meals should be given because they can be more completely digested by the limited amounts of juices, the number of enzymes, and the muscular contractions than can large meals.
4. Frequent feedings are essential, not only to replenish the glucose supply but also to enable the diet to meet the protein, vitamin, and mineral requirements.

The liquid, or fluid, diet. A liquid, or fluid, diet is usually the first to be recommended by the physician, in case of severe illness. If the physician designates this diet, he means that the patient should be given mostly: fruit juices, milk, cream soups, cereal gruels, and eggs.

Most fruit juices, which are refreshing and generally enjoyed, contain from 10 to 15 per cent sugar and can be further sweet-

ened to make an ideal means of assuring a normal supply of blood glucose. Aside from these, citrus juices, as the richest source of ascorbic acid, are valuable in helping the body fight almost any infection or disease. In cases of acute infection, citrus juices should be given almost hourly. Other juices, such as carrot, tomato, pineapple, pear, peach, apricot, loganberry, and grape, may be used, but they should be chosen for their nutritive value rather than by the preference of the patient. For example, if high vitamin A is needed, carrot, tomato, and apricot juice should be given rather than pineapple juice. If fruit juices alone seem too sharp, or if a high-calorie diet is desired because the patient is extremely thin or if a fever exists, delicious drinks may be made by adding cream to fruit juices. These are prepared by mixing a half cup of cream with a half cup of orange, pear, peach, or apricot juice, and about two teaspoonfuls of sugar.

Milk should be used as the principal source of protein. If the illness is a long one which requires the continuation of a fluid diet, as much as two or more quarts of milk might be given daily. Buttermilk or sour milk may be taken, either in the place of or in addition to sweet milk. Buttermilk mixed with pineapple or other fruit juice is a palatable drink. Sweet milk may be served either plain, or modified in any way to make it palatable to the patient. It may be warmed or chilled, sweetened or unsweetened, made into malts or other milk drinks, cream soups, ice cream, milk sherbets, or junkets. Malted milks may be served either hot or cold, and molasses or fruit malts, containing ice cream, are allowed as long as the fruit is puréed. Postum, made with hot milk rather than water, is usually enjoyed. A palatable drink may be prepared by adding thoroughly mashed, very ripe bananas to milk. Blackstrap molasses, stirred into milk, supplies sugar, many B vitamins, iron, copper, and other minerals.

Cream soups have the advantage of incorporating vegetables into the diet. Butter should be added to them if extra calories are needed. These soups may be prepared with tomato, spinach, potato, peas, asparagus, carrots, or other puréed vegetables. The vegetable used should be chosen, however, for its nutritive value, depending upon the nature of the illness.

Gruels should always be prepared with milk rather than water. For a liquid diet, they are usually made by adding one to three tablespoonfuls of cereal to one cup of hot milk. Unless the physician specifies otherwise, only wheat germ or whole-grain cereal should be used. Wheat germ is superior to all other cereals because of its high content of B vitamins, which are almost always deficient in liquid diets. Quick-cooking oatmeal and any 100 per cent whole wheat are allowed, but if the texture is rough, these should be put through a strainer before serving. Since both thiamin and protein are harmed by long cooking, no cereal should be used which requires longer than five or ten minutes to prepare.

Raw eggs have long been given on a liquid diet but the wisdom of this practice is now being seriously questioned. Uncooked eggs have such a slimy consistency that enzymes cannot penetrate them, hence raw eggs have been found to leave the stomach almost wholly undigested. Since they are liquid, they also leave the stomach too quickly for digestion to take place. A toxic substance in raw egg white combines with *biotin,* one of the vitamins of the B complex, and prevents it from entering the blood. For these reasons it may be better never to serve raw egg white, particularly on the diet of an ill person.

If egg yolk is beaten into a foam it becomes somewhat solid and its substance is so divided that enzymes can more readily penetrate it. Stiffly beaten egg yolk may be added to milk in the form of eggnog, to the cream and fruit-juice mixtures, or to hot gruels. A thin custard suitable for a liquid diet may be

prepared by heating milk in a double boiler, and adding beaten egg yolk, sugar, and vanilla. Aside from vitamins, each egg yolk contributes about six grams of protein, as well as valuable iron and copper.

Broths and consommés, formerly recommended on liquid diets, have almost no nutritional value. They seem to satisfy the appetite, which is usually poor during illness, and may thus prevent the patient from taking other foods which could contribute more to his recovery. The only argument for serving broths and consommés is that they stimulate the flow of gastric juices and, in this way, may contribute to the more complete digestion of other foods. Whether or not their disadvantages are balanced by their advantage is a question. Certainly they should never be given a prominent place in the diet.

As much water should be allowed the patient as he desires, unless restricted by the physician. Since most liquids, however, contain sugars, vitamins, minerals, and perhaps proteins, as well as 85 to 90 per cent water, they are often preferable to drinking water. When the patient enjoys juices as much as he does water, orange, grapefruit, pineapple, and other juices should be given him instead of water, in any quantity which he desires. If the budget is so limited that juices cannot be purchased in the amounts needed, water in which vegetables have been cooked contains many vitamins and minerals and would therefore be much more valuable for drinking than water alone.

Example of liquid diet. The time at which foods should be given and the amounts for a single day might be as follows:

7:00 A.M. 1 cup of milk: may be sweetened with blackstrap molasses or taken as postum or malted milk

8:00 A.M. ¾ cup wheat-germ gruel; sugar and cream added if desired

9:30 A.M. 1 cup fresh, strained orange juice or orange shake

11:00 A.M. 1 cup milk with one tablespoonful of black molasses
1:00 P.M. 1 cup cream of spinach soup
3:00 P.M. 1 cup grapefruit juice
5:00 P.M. ½ cup apricot ice cream
7:00 P.M. ¾ cup wheat-germ gruel; sugar and cream added if desired
9:00 P.M. eggnog: 1 cup milk, 2 egg yolks, 1 tablespoon sugar
1:00 P.M. (if awake) 1 cup pineapple juice

When a liquid diet is to be given over a period of weeks, much care must be taken to make it meet all the body requirements. If the diet cannot be made entirely adequate, the problem should be discussed with the physician in order that he may supplement it with vitamins and minerals in concentrated form. To prevent body proteins from being used for calories, the calorie value of the diet must be ample to supply all the patient's needs. A high-calorie diet might be as follows:

7:00 A.M. 1 cup hot malted milk, 1 tablespoonful of black molasses
8:00 A.M. 1 cup grapefruit juice with 1 tablespoonful sugar
9:00 A.M. ¾ cup wheat-germ gruel to which is added 1 beaten egg yolk and 1 teaspoonful of butter
11:00 A.M. 1 cup cream of pea soup to which is added 1 egg yolk and 1 tablespoonful butter
1:00 P.M. 1 cup orange drink made with ½ cup orange juice, ½ cup cream, 1 tablespoonful sugar
3:00 P.M. 1 cup pineapple malt containing 1 egg yolk
5:00 P.M. 1 cup milk and 1 tablespoonful of black molasses
7:00 P.M. ¾ cup oatmeal gruel, 1 teaspoonful butter
9:00 P.M. ½ cup buttermilk with ½ cup pineapple juice
11:00 P.M. (if awake) hot malt: 1 cup milk, 3 tablespoonfuls of malted milk, 2 teaspoonfuls of sugar

Soft, or bland, diet. As the patient improves, the liquid diet is usually followed by a soft, or bland, diet. On the other hand, in cases where the patient is not severely ill, the physician may

prescribe a soft diet immediately. All the foods given on the liquid diet are allowed and a number of simple dishes of soft foods are introduced.

Thin gruels may now give place to ordinary cooked cereals provided these are soft, finely ground, or strained. Bran-free wheat germ should still be served in preference to all other cereals. Quick-cooking rolled oats, brown rice, whole buckwheat, oatmeal, or any smooth whole-grain cereal may be used and served with butter, cream, or sugar, as the patient prefers.

Meats and fish are generally omitted from the soft diet because these foods, if not completely digested, are readily broken down by bacteria in the intestinal tract. As in the liquid diet, the protein requirements must be met largely by milk and eggs.

Cooked eggs are allowed, and may now be served in soufflés, puddings, and baked custards. They may be scrambled, or made into an omelet, provided the fat used is butter, cream, or vegetable oil and not bacon grease or other solid fat. In cooking eggs, low heat should be used in order to prevent the texture of the eggs from becoming tough. The raw egg yolks allowed on the liquid diet should give place to cooked eggs which digest more completely. Whipped drinks, which contain raw egg white and which were formerly used on a soft diet, should be avoided, but egg white is allowed whenever cooked.

Puréed or mashed vegetables, such as those prepared for infants, are given and may be served with butter, creamed, in cream soups, or in soufflés. Mashed or baked potatoes are allowed. Sweet potatoes and yams, which contain more fiber than do white potatoes, should be given with caution.

Toast is allowed on the soft diet, and may be added to soups, or served in the form of milk toast. Unless the physician specifies otherwise, it should always be made from 100 per cent whole grain which has been finely ground, such as that used in rye or soybean bread, and in some 100 per cent whole-wheat

breads. Bread containing large pieces of bran or unbroken kernels should be avoided. Although part of the protein and thiamin are destroyed by toasting, crisp toast is usually given because it can be either broken or chewed into tiny particles. For this reason, toast for an ill person should not be buttered when hot, as its crispness is then destroyed. If the patient digests his food well and has no discomfort, untoasted bread may be given to greater advantage than toast.

Soft fruits, strained, mashed, or puréed, are allowed, and may be served either alone or added to gelatin desserts, ice cream, and sherbets. Ripe, mashed bananas are especially valuable and, if folded into whipped cream, are usually much enjoyed.

Puddings and gelatin desserts may be served in addition to the junkets, ice creams, ices, and sherbets already allowed. Effort must be made to see that the maximum amount of nourishing food is included in each recipe. For example, gelatin should be made with fruit or vegetable juices rather than with water; sherbets should be prepared with milk and puréed fruits, and ices with pure fruit juices.

Small, frequent meals should be continued. A rather good rule of thumb to remember is that no food or amount of food should be served on the soft diet which could not wisely be given to a six-months-old baby.

Example of soft diet. The following program is typical of that given in one day to a patient who is allowed a soft diet:

7:00 A.M.	1 cup hot milk; may be sweetened with black molasses or taken as postum or malted milk
8:30 A.M.	1 cup of fresh, strained orange juice; ½ cup wheat-germ cereal served with top milk; one thin slice toast (butter served separately)
10:30 A.M.	1 cup milk with 1 teaspoonful blackstrap molasses
12:00	1 cup cream of asparagus soup; one thin slice toast

(butter served separately); ½ cup carrot soufflé; ½ cup puréed apricots

2:30 P.M. 1 cup orange juice; 1 mashed banana with 1 tablespoonful of whipped cream

5:00 P.M. 1 egg omelet; 1 small baked potato with butter; 2 tablespoonfuls of puréed squash; ½ cup caramel junket

7:30 P.M. 1 cup pineapple sherbet; 1 glass of milk with 1 tablespoonful black molasses

10:30 P.M. 1 cup hot malted milk; 1 thin slice toast

Light or convalescent diet. The light or convalescent diet should start upon the physician's recommendation and be continued until recovery is complete. The purpose of the light diet is to supply all of the body requirements and at the same time limit foods to those which are least likely to disturb digestion. With a few exceptions this diet is similar to the ordinary choice of food.

The foods to be avoided are largely those which, for one reason or another, do not digest completely. The undigested food supports the growth of bacteria, particularly in the large intestine. In the bacterial breakdown of undigested foods, gas is formed which may severely distress the patient.

The foods to be avoided fall largely into four classes:

1. We lack enzymes to digest foods which have a rather large content of cellulose, or fiber. These include most of the salad vegetables which are usually served raw, such as celery, lettuce, cabbage, green onions, peppers, and watercress.

2. Foods which have hard textures may not be chewed enough to be broken into particles sufficiently small for enzymes to completely surround. Examples are nuts, cucumbers, raw carrots and turnips, and such fruits as cantaloupe, raw apples, and pears unless very ripe.

3. Foods which are highly seasoned with pepper and spices may

irritate the stomach and intestinal walls, especially if the illness is a digestive upset.

4. Fried foods and those containing fat or prepared with fat which does not melt at body temperature and for this reason does not digest completely. This classification includes pork in any form, the fat of veal, beef, lamb, and mutton, rich beef stews, fatty vegetable soups, and omelets prepared in bacon grease. Although cream, butter, chicken fat, and vegetable and fish oils are readily digested, fried foods are not recommended during illness regardless of the fat used, because the digestion is often impaired. A coating of undigested fat over any food can prevent the enzymes which break down starches, sugars, and proteins, from reaching the food.

All the foods given on the liquid and soft diets may be continued. Lean meats, fish, and fowl are allowed. Vegetables should be puréed, mashed, or so soft that they may be thoroughly chewed. Salads should be confined to peeled tomatoes with cottage cheese, gelatin aspics made of vegetable and fruit juices, and cottage or cream cheese combined with cooked fruits such as pears, apricots, peaches, or prunes. Stewed fruits should be used rather than raw except when the texture is soft as is that of very ripe bananas and apricots.

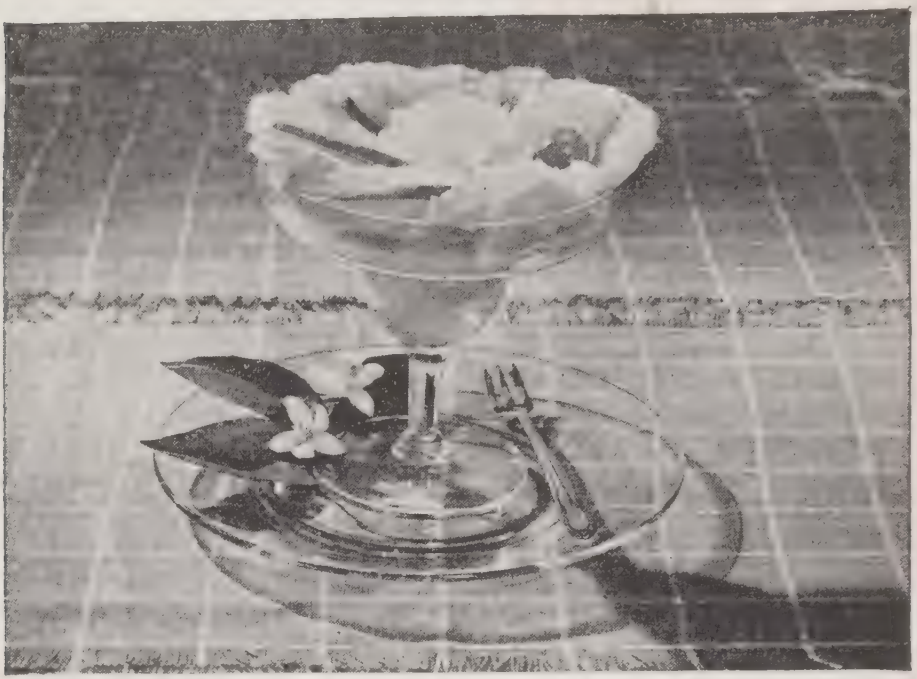
The number of daily feedings may be decreased to three meals and three midmeals, but the meals should be smaller and the midmeals larger than in the case of a well person. Although the diet should be simple and few kinds of foods served at one time, great care should be taken in the preparation and in the tasteful seasoning of the food. The tray should be made attractive in appearance by colorful dishes and serving linen, and perhaps a flower. The hot foods should be piping hot and the cold foods thoroughly chilled at the time they reach the patient.

Example of light diet. The following program is typical of that given in one day to a patient who is allowed a light diet:

Breakfast:	1 glass of fresh citrus juice
	stewed fruits (such as prunes, apricots, or peaches)
	wheat-germ or whole-grain cereal with top milk
	poached egg
	dry toast (butter served separately)
	1 cup fresh milk with ¼ cup powdered milk; may be flavored with postum or coffee
10:30 A.M.	1 glass milk with 1 teaspoonful blackstrap molasses
	1 ripe banana
Dinner:	cream of mushroom soup
	roasted or broiled lean beef, lamb, mutton, chicken, or fish
	baked potato or whole-wheat macaroni or spaghetti or brown rice
	stewed tomatoes
	mashed banana squash
	whole-wheat bread and butter
	stewed fruit
3:30 P.M.	1 glass of fresh orange or grapefruit juice
	1 cup baked custard
Supper:	plain omelet or soufflé
	puréed carrots
	whole-wheat bread and butter
	cottage cheese and tomato salad (lettuce not eaten)
	applesauce
9:30 P.M.	hot malted milk with three graham crackers

Precautions in planning diets for the sick. The comfort of the patient and the speed of his recovery depends on the careful preparation and the adequacy of his diet. Each food chosen should build the maximum health possible. Foods made from white flour, such as cake, crackers, cookies, macaroni, noodles, and spaghetti, should be avoided. The calories furnished by refined foods can be better supplied by natural foods containing larger amounts of proteins, vitamins, and minerals.

If any food must be omitted from the diet which is a de-



A colorful addition to the tray of a convalescent who is allowed fresh fruit.

pendable source of a body requirement, care must be taken that other foods supplying that same requirement are substituted in its place. For example, if oranges are forbidden, adequate ascorbic acid from other sources must be worked into the diet.

Before nutrition was as thoroughly understood as it is now, it was often true that when a patient was most in need of a completely adequate diet, he actually received a diet which was most inadequate. With careful planning and close co-operation with the physician, the diet may be made excellent even though the difficulties to be overcome are many.

Case History

A. B. was a 34-year-old woman who had been seriously ill for three years. She had undergone surgery repeatedly, and at many times she had not been expected to live. Even when recovery seemed possible, she took little interest in her food, ate only foods she

happened to enjoy, which were largely refined, and often sent her tray back untouched. Nevertheless she sincerely wished to get well.

Her physician suggested that she study nutrition and brought her a number of books on the subject. She read these, and soon became enthusiastic in applying her new knowledge. At this time she weighed only 86 pounds, although her ideal weight was 134.

She set for herself one rule from which she never wavered: every food which went into her mouth had to build the maximum amount of health possible. She computed the number of calories and the amounts of carbohydrate, fat, protein, vitamins, and minerals she would normally require, and, with the aid of her physician, determined the requirements which, because of her condition, needed to be increased above normal quantities. Each day she planned her diet to include all of these substances in the amounts which she, as an individual, required.

Her improvement was spectacular. Six months later she had not only been allowed to leave the hospital, but she had gained 42 pounds. She felt energetic, looked the picture of health, and appeared years younger than she actually was. Friends who had not seen her for some time failed to recognize her. Because she understands so thoroughly both the meaning of sickness and of health, she expects to apply her rule throughout life.

She gained vitality through planned nutrition.

Projects

1. Make out a liquid diet which includes 400 milligrams of ascorbic acid for a person suffering from an acute infection.
2. Plan a soft diet containing 20,000 units of vitamin A, 5 milligrams of thiamin in the form of the complex, 200 milligrams of ascorbic acid, 800 units of vitamin D, and 60 grams of protein. Be careful to keep servings in amounts which may be eaten by an ill person.
3. By using the tables on page 33 and pages 442–465, determine the kind and amounts of food which might be given each hour to supply 20 grams of carbohydrate. The foods may be either liquid or soft.
4. By using your own requirements for calories, protein, calcium,

phosphorus, iron, vitamins A, D, thiamin, riboflavin, niacin, and ascorbic acid, plan a light diet which would meet your needs for one day. Does the diet contain iodine, pyridoxin, unsaturated fatty acids, and trace minerals?

Topics for Discussion

1. Should a fever patient who is using his body muscles as the principal source of calories be given a diet rich in proteins, or in fats and carbohydrates? Why?
2. What is the advantage of starch and fat being digested slowly rather than rapidly?
3. Foods which leave the stomach rapidly have, in the past, been thought to be those which digest most quickly. Why is this line of reasoning incorrect? Under normal conditions, how could fat on meat aid protein digestion? Why is such fat removed in feeding the sick?
4. Obtain a dietetics text published ten or more years ago. What body requirements are undersupplied in the diets suggested? What changes have been made in preparing food for the sick?

Chapter 40

VITALITY THROUGH PLANNED NUTRITION

The achievement of vitality and health is never an end in itself. Health is merely an agency which allows clear thinking, moral courage, and abounding energy for work and play. Health permits forgetfulness of one's physical self, an unawareness that such organs as the heart, the digestive tract, the nerves, and the lungs exist, because all of them function so normally that they do not call attention to themselves. At the same time, abundant health expresses itself in an awareness of sheer physical well-being: muscles which urge the body into activity; skin which tingles and glows; fearless optimism which carries one over difficulties; and a hidden consciousness that the beauty which comes only from full health is to be had for the planning.

Relation of adequate nutrition to mental health. Many studies have shown that a close correlation exists between adequate nutrition and mental health. When children in lower grades are compared with those of the same age in higher grades, the latter have been found to have the better physical development. Individuals who are physically inferior are not necessarily mentally inferior, but, as a whole, both mental and physical development go hand in hand.

The improvement in grades and mental alertness, as well as physical health, which became evident almost immediately after adequate school lunches were given in order to utilize surplus foods, furnishes an excellent example of this correlation.

Abundant health expresses itself in an awareness of sheer physical well-being.

No child should be called dull or mentally inferior until his daily intake of all body requirements has been computed, and his diet is more than adequate in every respect.

Relation of adequate nutrition to moral health. A close correlation also exists between adequate nutrition and moral health. This correlation is stressed by Dr. Weston Price, who has studied primitive races the world over. He stresses that when these people are eating native, unrefined foods, not only is their physical development near perfection, but often no words exist in their languages to express crimes and other immoral behavior. The moral character is unusually fine. Since these people live in isolated places where little agriculture is carried on, when they adopt the white man's diet, the foods are necessarily those which must be shipped in and which must keep well, such as white flour, sugar, and canned stuffs. On this inadequate diet, physical degeneration takes place within a few years, and simultaneously crime becomes rampant.

Recognizing health. The average person fails to recognize full health. Since this is true, he often considers himself well when he actually is not. The person who is unaware of the symptoms which indicate that his health is below par will take no step to correct them. As a result, minor abnormalities, uncorrected, frequently lead to serious disease. It is probably true that every ill person has been well at some time during his life. Had he recognized the subtle deviations from health, and corrected them, serious illness might have been prevented in the majority of cases.

Those oversized foreheads show not brain but bone,
Resulting from rickets ere children are grown.

It is of tremendous importance that you recognize full health, in order that you may strive to attain it. It is of equal importance for you to recognize deviations from health so that you may correct them before illness results.

In order to give you some standard for judging health and to call attention to many deviations from health which should never be taken for granted, the following score card has been prepared. As you read each item, think back over the information gained to see how each is affected by your choice of food. Some of the abnormalities listed, such as those of the skeleton,

are results of rickets which you are unable to change. An awareness of them, however, will help you to prevent these abnormalities in your children.

Judge yourself and the members of your family by this standard. If you believe the person you judge to be perfect, give ten points for each topic, or grade down correspondingly. A perfect score would be 350 points. Your personal score need not be compared with that of other members of the class. Your health is yours alone, and you must be the judge.

The health score card is not complete, and not all the topics are of equal importance.

Yourself in years to come. Observe people who are ten, twenty, and more years older than you are. Then study yourself in the mirror and imagine the years ticking by. Are you girls going to be like many of the women you have observed, fat and dumpy, with pale cheeks covered with rouge? Are you going to be thin and nervous, with faces drawn with fatigue? Will you waddle along with an ugly, shuffling gait rather than carry yourself with grace and poise? Will your cheeks sink in where teeth are missing? Will your hair be prematurely gray? Will your chin sag into wrinkles because of flabby muscles? You will hate these changes if they come. Yet they need not come.

What will you boys be like as years go by? Will you have drooping shoulders and a protruding abdomen? Will shiny baldness show where your hair is now? Will your nerves be strained to instability and quick anger? Will you fight off fatigue with coffee and alcohol? You will hate the changes of physical degeneration, although you may be less frank to admit it than girls are.

Abnormalities which are seen so frequently as to be accepted as inevitable may be produced either early or late in animals, depending upon the adequacy of the diet. Many abnormalities

HEALTH SCORE CARD

OBSERVE OR CONSIDER	NORMAL CONDITIONS	ABNORMAL CONDITIONS
Appetite	ready for meals, taking pleasure in eating health-building foods	excessively disinterested in food; disliking many foods; craving sweets
Breathing	deep; regular; with mouth closed and breath sweet	shallow; irregular; with mouth open; short winded on slight exertion; with offensive odor to breath
Color	of mucous membranes, ears, cheeks, lips, and fingernails, pink—pink glow to skin on all parts of body	of mucous membranes, ears, cheeks, lips and nails—pale
Digestion	good, as shown by complete unawareness of digestion	poor, as shown by belching, gas, indigestion, car sickness, occasional nausea, or vomiting
Disposition	cheerful, pleasant, even-tempered in times of stress	surly, irritable, grouchy, uncooperative, quick to anger
Elimination	once daily; with feces formed, soft, moist, free from odor; without laxatives	irregular; with feces hard, dry; not formed; having offensive odor; obtained with use of laxatives
Eyes	bright; free from underlying circles; not sensitive to light; having a direct, alert glance, without frowning or squinting	dull; with underlying circles; sensitive to bright light; with frowning, squinting, shifting glance
Facial Expression	radiating health whether animated or in repose; relaxed, showing happiness and courage	strained, tense, drawn; showing fatigue, worry, or sadness
Gums	smooth; fitting tightly at the base of each tooth; free from bleeding	puffy, swollen, sore; bleeding easily; withdrawn from base of tooth
Hair	glossy, lustrous, alive; with scalp clean, pink, free from dandruff	coarse, dull, lifeless, falling, thin, too oily; with scalp pale in color, scaly, dry, dandruffy
Hands	free from tremor; with palms slightly yellow; with nails strong, not easily broken, smooth	showing tremor of fingers; with palms white or bluish; with nails which peel, break easily, or are ridged

OBSERVE OR CONSIDER	NORMAL CONDITIONS	ABNORMAL CONDITIONS
Heart	steady (about 72 beats per minute); with strong, steady, regular beats; without the person being aware of the heartbeat	weak or irregular beat (resting pulse either above or below 72); with person aware of his heart beat
Mental Ability	alert, mentally eager; able to concentrate and think clearly	having sluggish thought processes; lacking intellectual eagerness; disinterested; forgetful; unable to concentrate
Mental Outlook	forward looking, courageous; unafraid; eager to attack any problem	apprehensive; easily depressed; disinterested; fearful of life
Moral Outlook	honest, courageous, fearless, willing to fight for what is right	afraid to stand for what is right; wanting something for nothing; cheating whenever possible
Muscle Tone	so firm that erect posture is unconsciously maintained	soft, flabby; unable to stand erect unless muscles are tensed
Neck	having no enlargement; with ligaments clearly seen on turning head	with fullness on either side of windpipe indicating enlarged thyroid glands
Nerves	steady, relaxed, permitting person to sleep easily	tense, irritable, unstable, flighty; causing person to bite fingernails and have difficulty in sleeping
Posture: Abdomen	flat because of contraction of vertical abdominal muscles anchored to raised sternum	protruding, sagging
Chest	high, well-rounded; with raised sternum	hollow, sagging
Feet	directly forward; with weight distributed evenly on both feet, and body supported 60 per cent on ball of foot, 40 per cent on heel	toeing either in or out; with too much weight on heel or small-toe border
Head	carried high; with ear on direct line with shoulder, hip, knee, and ankle joints; with chin at right angle to head; with back of neck in straight line from shoulders	thrown forward or too far back; with chin sagging or too high; with back of neck curved into a U

OBSERVE OR CONSIDER	NORMAL CONDITIONS	ABNORMAL CONDITIONS
Posture: Hips	with buttocks down and forward; with pelvic bones forming support for internal organs; in profile, hip joint directly above knee and ankle joints	with buttocks too far back and carried high, and pelvic bone tipped forward so that internal organs are not supported
Legs	straight and at right angles to feet; with knee caps directly forward	with knee caps turned outward; with lower leg circling out and back from ankle
Shoulders	flattened into perpendicular plane; with shoulder tips back	rounded; with shoulder tips forward
Resistance to Infections	freedom from all infections and illness	susceptible to infections and illness of any kind
Skin	smooth, turgent, soft, slightly moist, faintly pink; free from bruises, even after severe blows	pale in color, dry, scaly, oily, with blemishes such as rashes, blackheads, whiteheads, boils; bruising easily
Skeletal Development: Chest	broad, rounded; with each rib under the one above	having pigeon chest, with narrow cavity and lower ribs flaring out
Face	well-developed, proportionate, with forehead flat with relation to face	with narrow cheek bones, overhanging or underdeveloped forehead, and chin either receding or prominent
Joints	without enlargements	with enlargements causing knock-knees, bowed legs, and enlarged wrists
Mouth	having round arch and teeth well spaced	having teeth crowded together, narrow arch, and protruding, badly aligned teeth
Step	elastic, rhythmical; with body so well balanced as to make step silent	shuffling, waddling; with body so out of balance as to make step heavy
Teeth	immune to decay	showing active decay
Vitality	energetic; possessing stamina and endurance	listless, tiring easily; lacking endurance; sluggish of movement; possessing nervous energy rather than vitality
Weight	correct for age and height	underweight or overweight according to individual standards

thought of as old-age changes may be completely avoided. Whether you look old at forty or young at eighty is largely up to you. If you desire health enough to work for it, you can stay young beyond your years: energetic, with nerves relaxed; eager for responsibility; finding the greater stimulus in the harder problem.

Just as you have enthusiasms and pleasures now which attracted you not at all five years ago, so does each year throughout life bring new joys, new interests, and new richness to the person who is truly alive. This ability to experience life to its fullest depends to a large extent upon abounding health.

Each year, as you grow older, it becomes increasingly difficult to maintain health without more careful planning. Each year, you will be likely to take less exercise. Many of you boys will sit day after day at office desks. You girls may get little exercise other than walking about your homes and to and from your cars. Unless you are to gain unwanted weight, you must eat few calories. Thousands of women today are eating as few as 1500 calories daily; men, as few as 1800. Even if refined foods are completely avoided, this extremely low-calorie intake means that the vitamin and mineral intake is also extremely low. So it is that planning your vitality by planning your nutrition will be needed even more in the future than now.

The need for planned nutrition. You have learned that you must plan every day's food intake to include each body requirement in amounts adequate for you as an individual, to be varied throughout life depending upon your activities. This is planned nutrition. Vitality comes through planned nutrition only when you actually eat foods which meet all of your individual requirements day after day. If you fail to plan your nutrition, even though you observe all the other rules of health,

the odds are against you. If you plan your nutrition and observe the rules of health, vitality throughout life may be yours.

Never before has there been such a need for vitality as now. Never before have there been such problems to be solved, in a world which so severely needs to be set to order. Never before has there been such a need for clear-thinking, generous men and women with character, integrity, moral courage, and spiritual appreciation. Never before has there been knowledge which, if applied, could lift the level of health from a national disgrace to radiant health for every individual.

Are you asking what you can do, you, as a mere individual? Do you realize that every world movement was once begun by some obscure individual? Think of the work of Jane Addams, which gave impetus to all branches of social service; of Pasteur, who revolutionized the foundations of medicine; of Florence Nightingale, who started the nursing profession; of Baden-Powell, who organized the Boy Scouts; of Clara Barton, who began the Red Cross. The amount which you alone can do cannot be overestimated. And did you even stop to think that the happiest people are those who forget themselves in generous enthusiasms and unselfish work which betters humanity?

You can, if you will, fulfill the pledge which the government once asked each citizen to take: "I pledge, on my honor as an American, that I will do all I can to build myself and my family and my neighbors into stronger, healthier Americans, as God meant us to be." If every high-school student in the United States would fulfill this pledge, think of the tremendous good which could be accomplished.

Each of you, if you will, can either directly or indirectly improve the vitality of hundreds of people, not for the sake of vitality alone but for greater happiness in life.

This is a challenge to each of you. Will you rise to it?

APPENDIX

Weights:

1 gamma, or microgram	= one-millionth of a gram
1000 gammas, or micrograms	= 1 milligram
1000 milligrams	= 1 gram
28.35 grams	= 1 ounce

Abbreviations:

International unit is abbreviated as **I.U.**

United States Pharmacopeia unit, is abbreviated **U.S.P.** unit.

Relation of weights to units:

1 milligram thiamin	= 333 I.U., or U.S.P. units
1 milligram riboflavin	= 333 Sherman-Bourquin units
1 milligram ascorbic acid	= 20 I.U., or U.S.P. units

Conversion tables:

To convert milligrams of calcium and phosphorus to grams, divide by 1000 by moving the decimal point three places to the left.

To convert gammas of thiamin and riboflavin to milligrams, divide by 1000 by moving the decimal point three places to the left.

To convert I.U., or U.S.P. units, of thiamin or riboflavin to gammas, multiply by 3.

To convert I.U., or U.S.P. units, of ascorbic acid to milligrams, divide by 20.

Limitations of the table of food analysis:

Space does not permit the listing of the analyses of all foods in the following table. When a diet includes a food which is not analyzed here, use the figures given for some food similar to it. The purpose of the table is to supply general information concerning food analysis rather than detailed knowledge of all foods.

More complete tables of food analysis can be found in government bulletins and in college textbooks in nutrition.

In the following table, in order to avoid decimals, amounts of calcium and phosphorus are given in milligrams instead of grams, and thiamin and riboflavin in gammas rather than milligrams. Vitamins A and D are in International, or United States Pharmacopeia units; ascorbic acid is in milligrams. With the exception of milk, average servings of food are given; weights and measures are of edible portions only. In case of cereals and legumes, raw weights are given with approximate cooked measure. Figures are for pasteurized milk and sulphur-dried fruits. Unless specified, vitamin and mineral contents are for uncooked foods, and allowances must be made for losses during cooking.

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
almonds	10	10 med.	0	15
apple	100	1 sm.	90	36
applesauce, sweetened	100	½ c.	60	25
apricots, dried	50	8 halves	6850	48
apricots, fresh	100	6 halves	7500	33
artichoke, Jerusalem	50	1 med.	200	75
asparagus, bleached	100	8 st.	0	150
asparagus, green	100	8 st.	1100	360
avocado	100	½ med.	500	120
bacon, crisp	10	1½ sl.	0	27
banana	100	1 med.	300	45
barley, pearl	100	½ c. raw	0	165
barley, whole	100	½ c. raw	—	2200
beans, kidney, cooked	100	½ c.	300	216
beans, Lima, dry, cooked	90	½ c.	0	300

Abbreviations Used in Table

* *probably rich source*
— *amount insignificant*
no data available
av. *average*
c. *standard measuring cup*
oz. *ounce*
in. *inch*
lg. *large*
med. *medium*
ser. *serving*
sl. *slice*
sq. *square*
sm. *small*
st. *stalk*
T. *tablespoonful*
t. *teaspoonful*

Equivalent Measures of Quantity

3 t. = 1 tablespoonful
16 T. = 1 standard measuring cup
8 oz. = 1 cup
32 oz. = 1 quart

VITAMINS			CALCIUM MILLIGRAMS	PHOSPHORUS MILLIGRAMS	IRON MILLIGRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MILLIGRAMS	D UNITS					
10	1	0	25	45	0.3	2	65
50	6	0	7	12	0.3	0	64
75	5	0	10	18	0.4	0	150
250	0	0	16	30	0.8	1	102
100	4	0	13	24	0.6	1	70
15	10	0	20	47	0.4	1	32
65	12	0	21	40	1	2	20
65	20	0	21	40	1	2	20
137	9	0	44	42	6.3	2	263
7	0	0	0	3	0.1	2	53
87	10	0	8	28	0.6	1	85
0	0	0	20	181	0.2	4	330
..	0	0	51	400	4.7	4	310
210	0	0	46	152	0.6	6	88
250	0	0	72	386	2.9	8	129

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
beans, Lima, green, cooked	100	½ c.	900	225
beans, navy, baked	100	½ c.	20	150
beans, string, green, cooked	100	¾ c.	950	60
beef broth	200	1 c.	0	..
beef, fat	113	4 oz. or 1 sl.	40	135
beef, lean	113	4 oz. or 1 sl.	60	140
beet greens, cooked	135	½ c.	22,000	100
beets	100	½ c.	50	41
blackberries	100	¾ c.	300	25
blueberries	100	¾ c.	35	45
bologna	50	10 sl. sm.	0	255
brains, beef	113	4 oz.	54	168
bran, wheat flakes	25	1 c.	25	240
bread, rye	30	1 sl.	—	66
bread, white, milk	30	1 sl.	10	15
bread, white, roll	50	1 lg.	12	24
bread, wholewheat, 100%	30	1 sl.	10	180
broccoli, flower	100	¾ c.	6000	120
broccoli, leaf	100	¾ c.	30,000	120
broccoli, stem	100	¾ c.	2000	..
Brussels sprouts	100	¾ c.	400	180
buckwheat, whole	100	5 T.	..	660
butter	10	2 t., 1 sq.	225	12
buttermilk	960	1 qt.	400	300
cabbage, inside leaves	100	1 c. raw	0	78

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
250	42	0	21	130	0.9	7	116
15	0	0	52	155	3.8	6	115
100	8	0	55	50	1.1	2	43
..	0	0	0	..	..	4	30
200	0	0	12	204	3	19	242
262	0	0	13	214	3.4	22	190
500	50	0	94	40	3.2	2	28
37	8	0	28	42	2.8	2	40
30	3	0	32	32	0.9	0	52
31	11	0	25	20	0.9	0	50
200	0	0	40	102	4.2	8	109
360	18	..	16	340	5.3	11	127
80	0	0	30	305	1.9	1	70
..	0	0	12	74	0.6	3	76
20	0	0	14	32	0.2	3	72
25	0	0	12	40	0.2	4	100
100	0	0	22	102	1.1	3	75
350	65	0	64	105	1.3	2	35
687	90	0	262	67	2.3	3	35
187	..	0	83	35	1.1	2	35
90	130	0	27	121	2.1	4	55
..	0	0	24	306	2.6	12	240
0	0	4	1	1	0	0	77
1850	0	5	1200	960	—	30	400
75	50	0	46	34	0.2	2	28

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
cabbage, Chinese	100	1 c. raw	5000	36
cabbage, green	100	1 c. raw	160	90
cake, chocolate	50	1 sl.	160	15
cake, devil's food	50	1 sl.	150	19
cake, sponge	25	1 sl.	160	36
candy, chocolate	15	1 piece	—	0
candy, chocolate nut	40	1 bar	—	..
candy, gumdrop	10	1 lg.	0	0
candy, marshmallow	6	1 av.	0	0
candy, milk chocolate	50	1 bar	—	0
candy, mint	6	1 piece	—	0
candy, peanut brittle	25	2x3x¼ in.	0	45
cantaloupe (see melon)				
carrots	100	½ c. diced	4500	70
cashew nuts	30	20 nuts	0	*
cauliflower	100	¾ c.	10	85
celery, bleached	100	4 st.	20	30
celery, green	100	4 st.	640	30
celery root	100	½ c.	..	..
cereal, whole wheat, cooked	100	⅔ c.	7	140
chard, leaves, cooked	100	½ c.	15,000	450
cheese, American	40	2x1x1 in.	1000	18
cheese, Cheddar	30	2 T.	500	45
cheese, cottage	100	½ c.	180	18
cheese, cream	20	1 T.	3500	10
cheese, Swiss	30	1 sl.	660	..

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
462	50	0	400	72	2.5	2	30
150	50	0	429	72	2.8	2	28
30	0	0	21	48	0.4	3	200
37	0	0	11	101	2.9	3	177
6	0	..	18	55	0.8	2	72
0	0	0	0	0	0	—	45
..	0	0	0	—	0	5	219
0	0	0	0	0	0	1	36
0	0	0	0	0	0	—	20
0	0	0	10	—	0	4	282
0	0	0	0	0	0	0	20
30	0	0	5	26	0.4	3	115
75	5	0	45	41	0.6	1	30
76	0	0	16	160	..	6	202
90	75	0	122	60	0.9	2	25
15	5	0	78	46	0.5	1	19
45	7	0	98	46	0.8	1	19
..	2	0	47	71	0.8	3	38
30	0	0	10	98	1.4	3	100
165	37	0	150	50	3.1	2	25
200	0	0	380	274	0.4	12	160
650	0	0	254	181	0.1	7	100
250	0	—	240	263	—	20	100
112	0	—	127	104	—	2	75
150	0	—	330	281	0.4	10	135

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
cherries, stoned	100	12 lg.	259	51
chestnuts, fresh	20	6 nuts	0	48
chicken	113	4 oz.	0	140
chocolate malted milk	350	13 oz.	2260	333
chocolate milk shake	350	13 oz.	1240	168
chocolate pudding [1]	125	½ c.	592	15
chocolate, sweetened	30	1 oz.	0	25
clams	113	6, or ¾ c.	20	21
coca cola	200	7 oz.	0	0
cocoa [2]	150	1 c.	300	30
cocoanut, dried	20	3 T.	..	15
cod-liver oil, U.S.P.	15	1 T.	10,000	0
cod fish	113	4 oz.	10	150
coffee, liquid	200	1 c.	0	0
collards, cooked	100	½ c.	6300	130
cookie, molasses	25	1 lg.	—	—
corn, canned, yellow	100	½ c.	900	130
corn, on cob, yellow	100	1 med.	860	209
corn oil	11	1 T.	0	0
corned beef	113	4 oz.	..	..
cornflakes	20	¾ c.	0	20
cornmeal, white	100	½ c.	0	110
cornmeal, yellow	100	½ c.	500	110
cottonseed oil	11	1 T.	0	0
crab	113	⅔ c.	..	135
Crackers, graham	20	2	0	48

[1] 100 gm. milk, ¼ egg
[2] 100 gm. milk

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
—	12	0	19	30	0.4	1	90
..	0	0	7	19	0.8	—	37
180	0	0	14	232	3.1	18	125
532	0	10	390	306	1.1	11	514
432	0	10	390	300	0.9	10	472
150	0	4	149	164	—	5	272
..	0	0	27	130	0.7	—	170
15	15	5	95	93	4.2	14	100
0	0	0	0	0	0	0	135
150	0	1	186	62	0.4	5	135
25	0	0	12	31	0.4	1	130
0	0	1700	0	0	0	0	100
192	0	—	12	120	0.6	16	70
0	0	0	0	0	0	0	0
*	70	0	207	75	3.4	3	41
..	0	0	39	25	1.5	2	100
120	4	0	6	103	0.4	4	120
55	8	0	8	103	0.4	3	90
0	0	0	0	0	0	0	100
*	0	0	13	119	6.8	16	196
20	0	0	10	38	0.1	2	100
82	0	0	16	152	0.5	8	270
100	0	0	16	152	0.9	8	272
0	0	0	0	0	0	0	100
420	12	..	17	181	0.1	16	80
..	0	0	4	20	0.2	2	84

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
crackers, soda	12	2 lg.	0	0
cranberries, sauce	100	¾ c.	30	0
cream, table, 20%	60	4 T.	510	30
cream, whipping, 40%	60	4 T.	1020	30
cream soup, spinach [1]	150	¾ c.	4800	87
cream soup, tomato [1]	150	¾ c.	1100	96
cucumbers	100	1 med.	35	60
custard [2]	130	½ c.	918	48
dandelion greens, cooked	100	½ c.	20,000	190
dates, dried, stoned	100	15 med.	155	60
doughnuts	100	2	190	18
duck	113	4 oz.	..	360
egg, whole	50	1 av.	600	65
egg white	30	1 white	0	5
egg yolk	20	1 yolk	600	60
eggplant	100	½ c.	70	42
endive	100	10 st.	15,000	58
escarol (chicory)	100	¾ c.	23,000	75
farina, raw, refined	20	3 T.	0	10
figs, dried	30	2 sm.	15	15
figs, fresh	50	2 lg.	50	37
fish (average)	113	4 oz.	16	148
flour, buckwheat	113	1 c.	0	300
flour, rye	113	1 c.	0	171
flour, soy bean	113	1 c.	..	650

[1] ½ c. milk, whole
3 T. vegetable

[2] ½ c. milk, whole
½ egg

VITAMINS			CALCIUM MILLIGRAMS	PHOSPHORUS MILLIGRAMS	IRON MILLIGRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MILLIGRAMS	D UNITS					
0	0	0	2	10	0	1	53
0	6	0	13	11	0.4	—	300
90	0	5	45	40	--	2	105
90	0	10	38	36	—	1	240
150	2	4	157	144	3.5	5	150
150	3	4	130	140	0.6	4	141
54	12	0	10	21	0.3	1	15
225	0	6	134	175	0.7	7	126
270	100	0	84	35	6	3	45
54	0	0	70	56	3.5	2	347
87	0	0	21	55	1.6	7	481
..	0	0	10	200	2.3	21	159
150	0	50	32	112	1.5	6	75
50	0	0	4	5	0	3	12
100	0	50	28	107	1.5	3	58
36	10	0	11	31	0.5	1	15
72	20	0	104	39	1.2	1	8
250	7	0	29	27	1.5	1	20
0	0	0	5	25	0.1	2	72
32	0	0	54	38	0.7	1	103
30	1	0	26	18	0.4	1	42
220	0	..	12	128	1.6	21	140
..	0	0	11	193	1.3	6	387
72	0	0	18	289	1.4	9	388
370	0	0	200	450	7.4	37	379

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
flour, wheat, fortified[1]	113	1 c.	0	450
flour, wheat, refined	113	1 c.	0	70
flour, wheat, whole grain	113	1 c.	42	450
frankfurters	113	2 links	0	*
gelatin, dried	10	1 T.	0	0
gingerale	200	7 oz.	0	0
goose	113	4 oz.	..	150
gooseberries	100	¾ c.	150	150
grapefruit, fresh	100	½ med.	20	70
grapefruit juice, fresh	240	1 c., or 8 oz.	50	75
grapefruit juice, canned	240	1 c., or 8 oz.	50	65
grape juice, canned	100	½ c.	0	20
grapes	100	1 sm. bunch	25	30
guavas	100	1	200	156
haddock	113	4 oz.	7	120
halibut	113	4 oz.	0	120
ham	113	4 oz.	0	800
heart, beef	113	4 oz.	..	660
herring	113	4 oz.	200	120
hominy, white	100	½ c.	0	54
honey	25	1 T.	0	0
huckleberries	100	½ c.	100	45
ice cream, commercial	100	½ c.	170	36
jams	50	4 t.	0	0
jellies	50	4 t.	0	0

[1] Fortified flour means that iron, thiamin, niacin, and sometimes calcium and riboflavin, have been added to refined flour.

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
220	0	0	270	90	3.3	10	354
54	0	0	20	90	1	10	354
160	0	0	45	423	5	12	361
..	0	0	7	117	1.6	14	244
0	0	0	0	17	..	8	34
0	0	0	0	0	0	0	90
..	0	0	10	175	2.4	22	153
..	25	0	40	50	0.4	1	37
60	45	0	21	20	0.2	0	36
144	108	0	42	40	0.4	1	72
144	72	0	42	40	0.4	1	100
20	0	0	11	10	0.3	0	60
24	3	0	19	35	0.7	1	80
105	125	0	15	16	3	1	56
198	0	..	18	197	0.5	17	72
222	0	..	20	200	1	19	121
225	0	0	13	54	5.7	20	248
900	4	0	12	129	3.7	17	96
330	0	..	23	246	0.6	19	394
0	0	0	12	112	0	0	355
0	1	0	0	6	0.1	0	101
21	8	0	25	20	0.2	1	60
150	0	2	202	74	0.6	2	208
—	0	0	—	—	—	0	176
—	0	0	—	—	—	0	156

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
jello [1]	200	¾ c.	0	0
kale, cooked	100	½ c.	20,000	189
ketchup, tomato	20	1 T.	—	..
kidney, beef	113	4 oz.	1100	300
kohlrabi	100	½ c.	..	30
lamb chop	113	2 chops	0	300
lamb, roast	113	4 oz.	0	225
lamb's-quarters (greens)	100	½ c.	19,000	180
lard	30	2 T.	2	51
leeks	100	½ c.	20	150
lemon juice	50	4 T.	0	24
lentils, cooked	100	½ c.	200	378
lettuce, green	100	10 leaves	2000	75
lettuce, white	100	¼ head	125	51
lime juice	50	¼ c.	65	..
liver, beef	113	4 oz. or 1 sl.	9000	300
liver, calf	113	4 oz. or 1 sl.	7000	250
liver, chicken	113	4 oz. or ½ c.	8000	210
liver, lamb	113	4 oz. or 1 sl.	9000	300
liver, pork	113	4 oz. or 1 sl.	6000	450
lobster, canned	100	½ c.	..	150
loganberries, canned	100	1 c.	..	33
macaroni, white, cooked	100	¾ c.	0	5
macaroni, whole wheat	100	¾ c.	0	410
malted milk, dry	30	2 T.	2040	330

[1] Made with water

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
0	0	0	0	0	0	2	112
570	96	0	195	67	2.5	4	45
..	—	0	3	8	0.2	—	21
2520	10	0	9	182	4.2	15	137
120	50	0	195	60	0.7	2	32
330	0	0	21	180	3.3	20	359
320	0	0	21	180	1.7	22	225
600	82	0	180	70	2.6	4	55
9	0	0	0	0	0	0	270
..	24	0	58	56	0.6	2	40
2	25	0	11	6	0.3	0	20
390	0	0	20	77	1.7	9	115
150	7	0	49	28	1.5	1	10
62	5	0	17	40	0.5	1	10
..	18	0	28	17	—	0	20
2500	30	20	11	368	9.2	20	140
2250	25	20	8	420	9.4	23	148
..	25	15	..	..	..	20	130
2500	20	17	8	400	7.9	20	120
2500	12	24	10	370	8.1	20	150
156	5	..	18	188	0.9	16	84
..	35	0	35	24	1.3	1	64
0	0	0	24	119	0.1	3	130
160	0	0	45	423	5.1	4	130
200	0	0	..	..	..	2	82

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
mandarin (orange)	100	2 sm.	150	80
margarine	28	1 oz.	. . [1]	0
marmalade, orange	25	1 T.	. .	0
mayonnaise	15	1 T.	—	. .
melon, cantaloupe	150	½ sm.	900	90
melon, honey dew	150	¼ med.	100	. .
melon, watermelon	300	1 med. ser.	450	180
milk, condensed	100	½ c.	680	96
milk, dried, skim	60	5 T.	0	340
milk, evaporated	100	½ c.	680	56
milk, fresh, dry feed	960	1 qt.	800	240
milk, fresh, green feed	960	1 qt.	3500	600
milk, fresh, skim	960	1 qt.	30	300
milk, fresh, whole, average	960	1 qt.	2920	300
milk, goat	960	1 qt.	1630	547
molasses, blackstrap	20	1 T.	0	49
molasses, blackstrap, fortified [2]	20	1 T.	0	1049
molasses, dark, unrefined	20	1 T.	0	0
molasses, light (corn syrup)	20	1 T.	0	0
muffin, bran	35	1 lg.	20	150
muffin, wheat-germ [3]	35	1 lg.	25	450
mushrooms	100	¾ c.	0	160
mustard greens, cooked	100	½ c.	11,000	138

[1] Present if the vitamin is added
[2] Fortified by adding 30 milligrams of thiamin to a pint of molasses
[3] 1 T. per muffin

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
150	46	0	45	21	0.5	0	61
0	0	..[1]	—	3	0.1	—	261
..	0	0	8	3	0.1	—	85
7	0	0	2	—	—	—	100
100	50	0	32	30	0.5	1	44
..	90	0	..	..	..	0	35
84	22	0	33	9	0.6	0	90
420	0	0	300	235	0.3	9	326
1625	0	0	1220	850	1.2	34	350
390	0	34[2]	250	200	0.5	8	150
1500	2	0	1100	930	1.6	33	660
2100	12	40	1220	960	2.8	33	660
1925	11	0	1220	960	2.4	34	370
1900	10	20	1200	930	2.2	33	660
950	12	..	1152	960	2	32	672
58	0	0	259	35	9.6	1	52
58	0	0	259	35	9.6	1	52
0	0	0	40	8	1.4	—	57
0	0	0	2	1	0	0	59
40	0	0	26	24	0.4	1	120
62	0	0	26	24	0.6	1	120
70	2	..	14	98	0.7	4	36
450	125	0	291	84	9.1	2	25

[1] If vitamin is added
[2] If irradiated

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
mutton, leg	113	4 oz.	0	360
oatmeal, cooked	20	½ c.	0	190
okra	100	½ c.	440	126
olives, green	25	5	50	0
olive oil	15	1 T.	0	0
onions, dry	100	2 sm.	0	42
onions, fresh	100	4 med.	60	42
orange	100	1 med.	190	90
orange juice, canned	240	1 c. or 8 oz.	460	225
orange, fresh	240	1 c. or 8 oz.	460	200
oysters	100	7 med.	250	225
parsley	50	½ c.	8000	57
parsnips	100	½ c.	100	120
peaches, dried	25	3 halves	1000	20
peaches, white, raw	100	3 halves	100	25
peaches, yellow, canned	100	2 lg. halves	600	24
peaches, yellow, raw	100	1 lg.	1000	25
peanut butter	34	2 T.	120	210
peanuts	20	18 nuts	70	225
pears	100	1 med.	17	30
peas, dried, cooked	20	½ c.	520	142
peas, fresh, cooked	100	½ c.	1500	390
pecans	33	10 lg.	90	100
peppers, green	100	1 med.	700	25
peppers, pimiento	100	2 med.	500	..
persimmon, Japanese	150	1 lg.	1600	..
pickles, cucumber	30	4 sm.	0	0

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
330	0	0	10	270	3	20	191
75	0	0	4	79	1.4	4	80
..	17	0	72	62	2.1	2	24
0	0	0	40	4	0.6	—	35
0	0	0	0	0	0	0	135
125	2	0	41	47	0.3	1	45
125	7	0	41	47	0.4	1	42
75	50	0	44	18	0.4	—	50
230	80	0	90	45	0.9	1	110
230	120	0	90	45	0.9	1	110
540	3	5	33	156	5.8	6	50
..	70	0	23	15	9.6	20	24
..	40	0	60	76	1.7	2	65
50	0	0	12	19	0.6	1	77
65	6	0	10	19	0.2	1	50
60	8	0	10	19	0.3	1	50
65	9	0	10	19	0.3	1	50
200	0	0	24	132	0.6	9	203
110	0	0	15	73	0.4	5	110
60	4	0	15	18	0.3	0	60
162	0	0	17	80	2.8	12	173
250	20	0	28	127	2	7	100
75	0	0	29	112	0.8	3	229
25	125	0	12	28	0.4	1	25
..	200	0	6	26	0.4	1	23
..	40	0	22	21	0.2	2	116
0	0	0	3	2	0.4	0	26

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
pie, apple [1]	100	1 lg. sl.	45	18
pie, apricot [1]	100	1 lg. sl.	3700	18
pineapple, canned	100	2 sl.	25	75
pineapple, fresh	100	⅔ c.	30	100
pineapple juice, canned	240	1 c. or 8 oz.	60	105
plums	100	3 med.	130	120
potatoes, sweet	100	1 med.	3600	155
potatoes, white, baked	100	1 med.	0	200
potatoes, white, raw	100	1 med.	0	220
potatoes, yam	100	1 med.	5000	180
pork chops	113	4 oz. or 2 chops	0	540
pork chops, lean, cooked	113	4 oz.	0	800
pork sausage	113	6 links	0	445
prunes, dried	50	6 med.	1500	75
pumpkin	100	½ c.	2500	56
rabbit	113	4 oz.	0	33
radishes	100	15 lg.	0	30
raisins, seeded	30	¼ c.	30	24
raspberries, fresh	100	½ c.	260	21
red-palm oil [2]	15	1 T.	50,000	0
rhubarb	100	½ c.	650	24
rice, brown, cooked	30	¾ c.	20	190
rice, polished, cooked	30	¾ c.	0	0
rice, puffed	10	½ c.	0	—

[1] ⅓ c. fruit in a slice
[2] Imported from India and Africa for making soaps and candles

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
25	2	0	8	39	0.2	3	274
50	3	0	11	45	0.4	3	274
25	10	0	8	26	0.1	0	65
25	38	0	8	26	0.2	0	57
60	25	0	20	69	0.2	0	129
56	5	0	20	27	0.5	1	80
150	25	0	19	45	0.9	3	130
75	20	0	13	53	1.5	3	92
75	33	0	13	53	1.5	3	90
360	6	0	44	50	1.1	2	150
312	0	0	16	180	2.5	14	340
225	0	0	18	180	5.7	23	240
300	0	0	7	116	1.6	10	402
325	4	0	27	57	1.5	2	173
57	8	0	23	50	0.9	1	27
72	0	0	20	201	0.6	20	192
54	25	0	21	29	0.9	1	22
50	0	0	20	44	0.9	1	105
..	30	0	41	38	0.8	1	45
0	0	0	0	0	0	0	100
24	12	0	48	18	0.5	1	20
75	0	0	22	112	1.6	4	117
0	0	0	3	33	0.2	2	117
0	0	0	1	9	0.1	1	35

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
rutabagas	100	¾ c.	25	75
salsify (oysterplant)	100	2 roots	0	..
sardines, canned	50	4	200	90
sauerkraut	100	¾ c.	20	8
salmon, canned	113	4 oz.	250	160
scallops	113	4 oz.	..	..
shredded wheat	30	1 biscuit	0	450
shrimp	30	6 med.	25	90
soybeans, dried, cooked	100	½ c.	10	525
soybeans, dried, uncooked	100	½ c.	25	1312
spaghetti, white, cooked	100	¾ c.	0	5
spaghetti, whole wheat, cooked	100	¾ c.	0	410
spinach, cooked	100	½ c.	11,000	90
squash, Hubbard, cooked	100	½ c.	4000	50
squash, summer, cooked	100	½ c.	1000	40
steak, beef	113	4 oz.	40	150
strawberries, fresh	100	½ c.	100	25
sugar, brown	12	1 T.	0	0
sugar, white, refined	12	1 T.	0	0
syrup, maple	25	1 T.	0	0
sweetbreads, beef	113	4 oz.	..	330
tangerine	100	2 med.	300	120
tapioca, cooked	30	½ c.	0	0
tea, liquid	200	1 c.	0	0

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
120	26	0	74	56	0.7	1	36
..	7	0	60	53	1.2	3	78
370	0	*	170	195	1	13	103
..	5	0	45	29	0.3	2	28
100	0	440	26	250	1.2	22	203
..	3	..	115	338	3.0	16	81
130	0	0	15	141	1.5	3	108
65	2	5	32	78	0.9	8	27
300	0	0	104	300	4	20	108
750	0	0	260	750	10.1	51	270
0	0	0	25	26	0.2	3	127
160	0	0	45	423	5.1	4	127
312	30	0	78	46	2.5	2	25
75	3	0	19	15	0.5	1	46
50	3	0	18	15	0.3	1	15
250	0	0	12	222	3.4	21	156
..	50	0	34	28	0.6	1	30
0	0	0	15	2	0.4	0	50
0	0	0	0	0	0	0	50
0	0	0	25	4	0.8	0	64
510	0	0	15	595	1.6	14	310
54	48	0	42	17	0.2	1	42
40	0	0	7	30	0.5	—	118
0	0	0	0	0	0	0	0

FOOD	WEIGHT, GRAMS	MEASURE	VITAMINS	
			A UNITS	THIAMIN GAMMAS
tomatoes, canned	100	½ c.	1000	75
tomatoes, fresh	100	1 med.	1500	110
tomato juice, canned	240	8 oz.	3700	195
tongue, beef	113	4 oz.	..	285
turnips, cooked	100	½ c.	0	62
turnips, raw	100	1 med.	0	65
turnip tops, cooked	100	½ c.	11,000	60
tuna, canned	30	¼ c.	20	30
turkey	113	4 oz.	0	150
veal chops	113	4 oz. or 2 chops	0	227
veal, cutlets	113	4 oz.	0	160
veal, leg, cooked	113	4 oz.	0	120
walnuts, black	30	¼ c.	40	110
walnuts, English	30	¼ c.	30	130
watercress	25	¾ c.	1250	30
wheatena, cooked	20	½ c.	7	290
wheat germ	100	½ c.	400	2600
white fish	113	4 oz.	..	120
yeast, bakers', fresh	15	1 cake	0	550
yeast, brewers', dried [1]	15	1 T., 30 tablets	0	2250

[1] Varies widely

VITAMINS			CALCIUM MILLI-GRAMS	PHOSPHO-RUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBOFLAVIN GAMMAS	ASCORBIC ACID MIL-LIGRAMS	D UNITS					
50	20	0	10	29	0.5	1	25
50	25	0	11	29	0.4	1	20
125	48	0	21	38	1	2	48
264	0	0	8	200	6	16	226
62	22	0	56	47	0.5	1	33
62	30	0	56	47	0.6	1	33
450	130	0	347	49	3.4	2	28
..	0	45	10	99	0.5	9	64
240	0	0	30	420	4.5	24	153
298	0	0	12	220	2.8	19	209
360	0	0	15	228	3	20	184
400	0	0	16	240	3	23	180
..	0	0	..	..	2	0	222
..	0	0	22	100	0.5	5	197
90	15	0	40	11	0.8	0	6
30	0	0	10	77	1.1	2	73
750	0	0	71	1050	7.5	24	220
..	0	..	25	263	0.4	22	150
300	0	0	2	74	—	2	20
1000	0	0	11	301	0.9	7	22

SUMMARY OF BODY REQUIREMENTS

Vitamin A

Solubility: in fat, therefore stored if any excess is taken.

Stability: destroyed by oxygen, especially during long cooking; destruction of carotene roughly proportional to loss of color.

Includes: carotene, or provitamin A, a yellow color found in the vegetable kingdom; primary vitamin A, colorless, from animal sources.

Possible toxicity: apparently is not toxic, even when massive doses are taken over long periods.

For maintenance requirements, see page 130.

Suggested ideal daily requirements:

Infants	*Children*	*Adults*
6,000	8,000–24,000	20,000

Vitamin-B Complex

Solubility: in water, therefore not stored in the body; lost in perspiration and urine.

Stability: thiamin and folic acid are harmed in cooking; riboflavin is destroyed by light; all are partially lost in water in which foods are soaked or cooked if water is thrown away.

Includes: twelve vitamins and perhaps more; action of these vitamins are interdependent. The entire complex can be supplied only by natural sources. The B vitamins known chemically: thiamin, riboflavin, pyridoxin, niacin amide, pantothenic acid, para amino benzoic acid, inositol, biotin, cholin, and folic acid.

Possible toxicity: never toxic if given in the form of foods which supply the entire complex; amounts not needed are thrown off in the urine. Large amounts of any single B vitamin may be toxic in that it increases the need for other B vitamins to the extent that deficiency symptoms frequently occur.

Suggested daily requirements: for maintenance requirements, see page 186. To arrive at possible ideal requirements, multiply maintenance requirements by two for an inactive individual, by three for an active person, and by four for anyone who shows deficiency symptoms.

Ascorbic acid

Solubility: in water, therefore not stored; lost in perspiration and urine.

Stability: easily destroyed, especially during storage and cooking; lost in water if the water in which foods are soaked or cooked is thrown away.

Chemical name: ascorbic acid.

Possible toxicity: apparently never toxic; when massive doses are taken, excess not needed is thrown off in the urine.

Suggested daily requirements: for maintenance requirements, see page 220; to arrive at possible ideal requirements, multiply maintenance requirements by three, or in milligrams per day:

Infants	*Children*	*Adults*
90	105–300	210–225

Vitamin D

Solubility: in fat, therefore stored in body.

Stability: not harmed by cooking or storage.

Possible toxicity: massive doses are sometimes toxic; margin of safety between recommended dose and toxic doses is extremely wide.

Chemical names: viosterol, irradiated ergosterol, calciferol.

Sources: fish-liver oils, irradiated ergosterol; summer sunshine; vitamin-D milk.

Suggested daily requirement in units per individual:

Infants	*Children*	*Adults*
1000–1500	1500–2000	800–1200

Vitamin E

Solubility: in fat, therefore stored in the body if excess is taken.

Stability: not harmed by cooking; destroyed when fat becomes rancid.

Chemical name: alpha-tocopherol.

Possible toxicity: apparently not toxic, even in massive doses.

Sources: wheat germ; wheat-germ oil; egg yolk; lettuce; whole-grain breads and cereals; vegetable oils.

Daily requirement: unknown; daily use of one or two of the above sources in the diet.

Vitamin K

Solubility: in fat, therefore stored if well absorbed.
Stability: not harmed in cooking; destroyed by long exposure to light.
Particular need: cannot be absorbed unless bile is present.
Sources: green leaves; vegetable oils; liver.
Daily requirement: unknown; frequent use of liver and green salads.

Calcium

Sources: milk, buttermilk, cheese, and foods prepared with them.
Storage: in the ends of the long bones if any excess is taken.
Particular need: not well used unless vitamin D is supplied.
Suggested daily requirement in milligrams per individual:

Infants	*Children*	*Adults*
1000	1000	1000

Phosphorus

Sources: milk, buttermilk, cheese; eggs; meats, fish, fowl; whole-grain breads and cereals.
Storage: in the ends of the long bones if any excess is taken and calcium is adequately supplied.
Particular need: not well absorbed or used unless vitamin D is supplied.
Suggested daily requirements in milligrams per individual:

Infants	*Children*	*Adults*
930	1000–1500	1500

Iron

Sources well utilized: liver, kidney, heart; blackstrap; molasses; egg yolk; whole-grain breads and cereals; dried fruits.
Suggested daily requirement in milligrams per individual:

Infants	*Children*	*Adults*
8	9–18	men 12
		women 15

Copper

Sources: blackstrap molasses; liver; nuts; egg yolk; sea foods; legumes; dried fruits; whole-grain breads and cereals.

Daily requirement: unknown; daily use of two of the above sources in the diet.

Iodine

Sources: iodized salt; sea foods, ocean fish.

Suggested daily requirement: continual use of iodized salt; sea foods or ocean fish once each week.

Sodium and Chlorine

Source: ordinary table salt.

Suggested daily need: one to two teaspoonfuls per day.

Condition where amount should be increased: in extremely hot weather.

Protein

Proteins of high biological value: essential for growth and maintenance of life; found in milk, eggs, cheese, meats, fish, soybeans, and nuts.

Proteins of medium or low biological value: inadequate to support growth alone; found in corn, legumes, cereals, gelatin.

Suggested daily requirement in grams to be supplied entirely by adequate proteins:

Infants	*Children*	*Adults*
1.5–2 per pound	(1–9 years) 40–70	70–80
	girls (13–20 years) 75–80	
	boys (13–20 years) 85–100	

Calories

Calorie intake must vary with: body weight; age; growth; exercise or physical work; temperature.

Suggested daily requirement in calories per pound of ideal weight:

Infants	*Children*	*Adults*
45	20–30	20, physical work
		15, sedentary work
		8–12, reducing

The following table is an analysis of foods eaten in one day by Helen H. age 17 years. If her diet is to be adequate, it must supply each requirement in the amount computed on page 470. With the exception of calories, excess over these amounts is advantageous, especially in the case of calcium, iron, and all vitamins except vitamin D.

FOOD	MEASURE	VITAMINS	
		A UNITS	THIAMIN GAMMAS
Breakfast			
apricots, dried	8 halves	6850	48
wheat-germ cereal	½ c.	400	2600
milk, evaporated	¼ c.	340	28
toast, whole wheat	1 sl.	10	180
butter	1 t.	112	6
milk, skim	1 gl.	7	75
Midmorning			
orange	1 med.	190	90
Lunch			
cheese omelet			
egg	1 av.	600	65
cheese, American	1-in. cube	500	19
milk, skim	¼ c.	—	18
lettuce and tomato salad			
lettuce, green	5 leaves	1000	37
tomato	1 med.	1500	110
mayonnaise	1 t.	—	0
milk, skim	1 gl.	7	75
grapefruit	½ med.	20	70
Midafternoon			
milk, skim	1 gl.	7	75
molasses, blackstrap	1 T.	0	49
Dinner			
tomato-juice cocktail	1 gl.	3700	195
liver, pork	1 sl.	6000	450
beet greens	½ c.	22,000	100
carrots	½ c., diced	4500	70
peach-cheese salad			
peach, yellow, canned	½ lg.	300	12
cottage cheese	1 T.	22	2
lettuce, green	2 leaves	400	14
milk, skim	1 gl.	7	75
cantaloupe	½ sm.	900	90
At bedtime			
orange	1 med.	190	90
fish-liver-oil capsule	1	10,000	0
Total for entire day		59,562	4643
Helen's daily requirements for full health		20,000	3000

Planned Nutrition

Since Helen's present weight is 130 and her ideal weight 120, she is eating slightly less than her normal calorie intake. In order to avoid excess weight, she drinks skim milk rather than whole milk and eats bread only at breakfast.

VITAMINS			CALCIUM MILLI-GRAMS	PHOS-PHORUS MILLI-GRAMS	IRON MILLI-GRAMS	PROTEIN GRAMS	CALORIES
RIBO-FLAVIN GAMMAS	ASCORBIC ACID MILLI-GRAMS	D UNITS					
250	0	0	16	30	0.8	1	102
750	0	0	71	1050	7.5	24	220
195	0	17 [1]	125	100	0.2	4	75
100	0	0	22	102	1.1	3	75
0	0	2	0	0	0	0	38
480	2	0	305	240	0.6	8	92
75	50	0	44	18	0.4	—	50
150	0	50	32	112	1.5	6	70
100	0	0	190	137	0.2	6	80
120	0	0	76	60	0.1	2	24
75	3	0	25	14	0.7	0	5
50	25	0	11	29	0.4	1	20
—	0	0	0	—	—	—	33
480	2	0	305	240	0.6	8	92
60	45	0	21	20	0.2	0	36
480	2	0	305	240	0.6	8	92
58	0	0	259	35	9.6	1	52
125	48	0	21	38	1.0	2	48
2500	12	24	10	370	8.1	20	150
500	50	0	94	40	3.2	2	28
75	5	0	45	41	0.6	1	30
30	4	0	5	10	0.1	0	25
40	0	—	122	40	0	2	12
30	—	0	10	4	—	0	1
480	2	0	305	240	0.6	8	92
100	50	0	32	30	0.5	1	44
75	50	0	44	18	0.4	—	50
0	0	2000	0	0	0	0	6
7378	350	2093	2495	3258	39	108	1642
5400	240	2000	1000	1500	18	80	1800

[1] If irradiated

How to Calculate a Daily Diet for an Adult

Vitamin A: maintenance requirements (p. 130), or 5000 × 4 = 20,000 units.

Vitamin-B complex: maintenance requirements (p. 186) × 2 for an inactive person, × 3 for an active one, × 4 for one showing deficiency symptoms.

Ascorbic acid: maintenance requirements (p. 220) × 3.

Vitamin D: 800–1200 units daily.

Vitamin E: eat one or two foods daily which are rich in the vitamin.

Calcium: 1000 milligrams daily

Phosphorus: 1500 milligrams daily

Iron: 12–15 milligrams daily

Copper: eat daily two foods which are rich in this mineral.

Protein: 70–80 grams daily, provided this amount is supplied entirely by adequate proteins.

Calories: ideal weight × 12, 15, or 29 calories per pound = daily need. Except when gaining or reducing is desired, calories need not be calculated.

Compare the amounts of each nutrient you need for full health with those you have actually eaten, as in the example given on pages 470–471.

Example:

Helen H. is 17 years old. Although she is quite active, her actual weight is 130, her ideal weight 120. Her ideal requirements for a day are as follows:

Vitamin A:	5,000 × 4 = 20,000 units.
Thiamin:	1.2 × 3 = 3.6 milligrams, or 3,600 gammas.
Riboflavin:	1.8 × 3 = 5.4 milligrams, or 5,400 gammas.
Ascorbic acid:	80 × 3 = 240 milligrams.
Vitamin D:	2,000 units.
Calcium:	1000 milligrams.
Phosphorus:	1500 milligrams.
Iron:	18 milligrams.
Protein:	80 grams.
Calories:	120 × 15 = 1800.

How to Conduct Rat-feeding Experiments

The only way to find out how food affects health is to try it on living subjects. At least one rat experiment should be conducted in each class.

How to obtain animals. White rats may be purchased at a nominal cost from the nearest biological laboratory, state university, or state agricultural extension station.

Age and sex of animals. The animals should be twenty-eight days old and weigh between 40 and 50 grams each. It is well to have two animals on each diet, preferably one male and one female. If it is impossible to secure one of each sex, all animals should be of the same sex, as the rate of growth of male and female is not the same. If all are of the same sex, identity may be indicated as the teacher may suggest.

Cages. A rounded cage 9 inches in diameter and 9 inches high is easily handled. These cages may be prepared of galvanized wire screening, with ¼-inch mesh, in 18-inch strips, sold at any hardware store. Cut the wire down the center, making 9-inch strips, 29 inches long. Fasten ends together with wire, leaving 1½-inch overlap. Cut a circle 9 inches in diameter for the top and fasten securely with wire. A 10-inch circle of wire mesh should be prepared for the bottom, hinged to the cage, and fastened tightly with wire to prevent animals from escaping during the night.

A second bottom must be placed under the cage. A shallow 10-inch layer-cake pan is most suitable. Absorbent paper, such as several layers of newspaper or paper towels, cut to fit the pan, may serve to collect urine and feces and should be changed daily.

Only one cage is needed for each diet used. A stout cardboard should be fastened to each cage, stating the diet and weight of the animals.

Food cups. Glass jars which are heavy enough to prevent tipping over may be used for food and water. Half-pint fruit jars are most satisfactory. The jars should be fastened securely to the side of the cage with copper wire passing around the neck of the jar.

Water and food should be allowed the animals at all times. Care must be taken that no unauthorized persons feed the animals and spoil the experiment.

Care of the animals. Students should take complete charge of the

experiment. The cages should be cleaned daily, the water cups washed, and the water and food cups refilled. On Friday, twice the amount of food and water generally consumed should be given.

Twice each week the wire-mesh bottom of the cages should be scrubbed with soap and water. During this time, the animals may be kept in a coffee tin perforated to admit air.

The animals should always be handled gently. If quick jerky movements are avoided, there is no danger of the rats biting. The animals should be kept in a warm place, out of drafts and direct sunlight. If it is necessary to move the animals from one building to another in cold weather, protect the cages with several layers of newspaper.

Weighing. All the animals should be weighed each week on a gram scales which may perhaps be borrowed from the chemistry department. The weighing may be done in a perforated coffee tin, if desirable. The weights should be carefully recorded and growth curves plotted by giving the week of the experiment on the horizontal line and weight in grams on the perpendicular line.

After each weighing, the animals should be closely observed by all members of the class. A discussion to bring out the comparison of the animals on the adequate and inadequate diets should take place, and the following conditions noted:

fur	cleanliness
eyes	temper
color of ears, tails, feet	vigor
appetite	posture
elimination	presence of infections

Experiment to show the value of vitamin A. The diets used in these experiments should be purchased from the same laboratory from which the animals are obtained. The vitamin-A-free diet usually consists of cornstarch, lard, milk protein from which all vitamin A has been extracted, salt mixture, brewers' yeast, and viosterol. The adequate diet, supplying vitamin A, differs only in that fish-liver oil is used instead of viosterol.

The food should be kept in a cool, dry place in jars distinctly labeled to prevent any mistakes being made.

When the animals, which lack vitamin A, look as if they might die (a condition which usually occurs at about the eleventh week),

the adequate diet may then be given them. This change is desirable to show that an incomplete diet during the growth period cannot be compensated for by a good diet later.

Experiment to show the value of the vitamin-B complex. Since whole-wheat bread is an excellent source of the vitamin-B complex, a very practical experiment may be conducted by giving one set of animals milk and 100 per cent whole-wheat bread, and giving another milk and white bread. If it is desired, a third group may be given fortified bread.

The experiment is much easier to conduct and the feeding simplified if whole dried milk and whole ground wheat are used instead of fresh milk and bread. In this case the diets may be made up in advance, one-third pound of dried milk being mixed with two-thirds pound of ground wheat. White flour or fortified flour may be used as two-thirds of the other diets in the place of bread.

In such an experiment, the male rats on each diet might be used for observation of the heartbeat, and the females reserved for further observation. If the animal getting only white bread appears to be about to die, whole wheat should be given and the increase in growth observed.

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